AUTICS

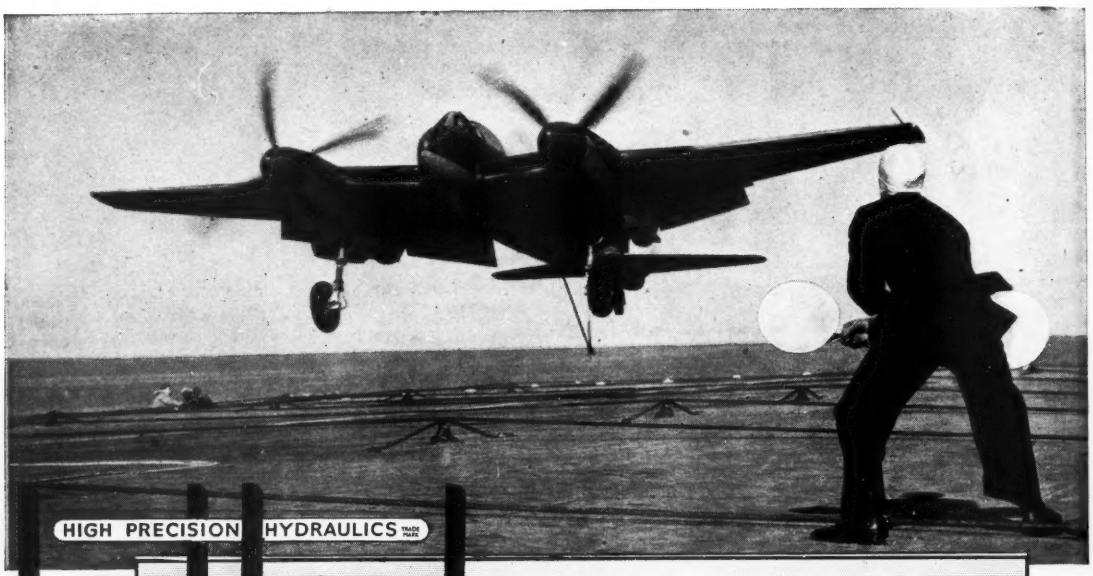
FLIGHT

AIRCRAFT ENGINEER

THE LI... OF CONGRESS SERIAL RECORD JUL 1 0 19...

Saunders-Roe flying boat of the future over Southampton Docks. *Painting by Frank Wootton*

SAUNDERS-ROE



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Lockheed solve another problem

Believed to be the fastest propeller-driven aircraft in production in the world, the Sea Hornet carries a 1,000 lb. bomb or drop tank on each wing-tip.

Problem : to fold the wings so that the aircraft can use the existing lifts, and to spread them again.

To do all this with the 1,000 lb. load in place on the wing-tip and in the teeth of a 35 knot wind from any direction or a 45 knot wind straight ahead.

The speed of movement must be substantially the same whether the wing carries its load or not.

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The Lockheed equipment solved the problem, permitting rapid movement of the wings, with a damping action to prevent excessive inertia loads towards the end of the travel.

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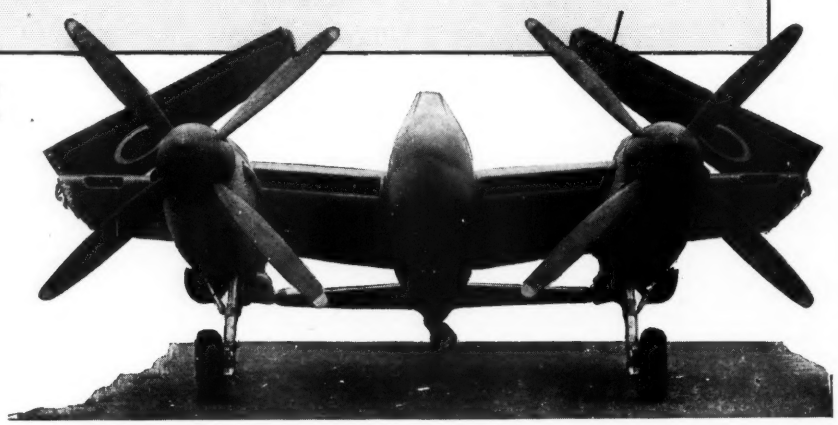
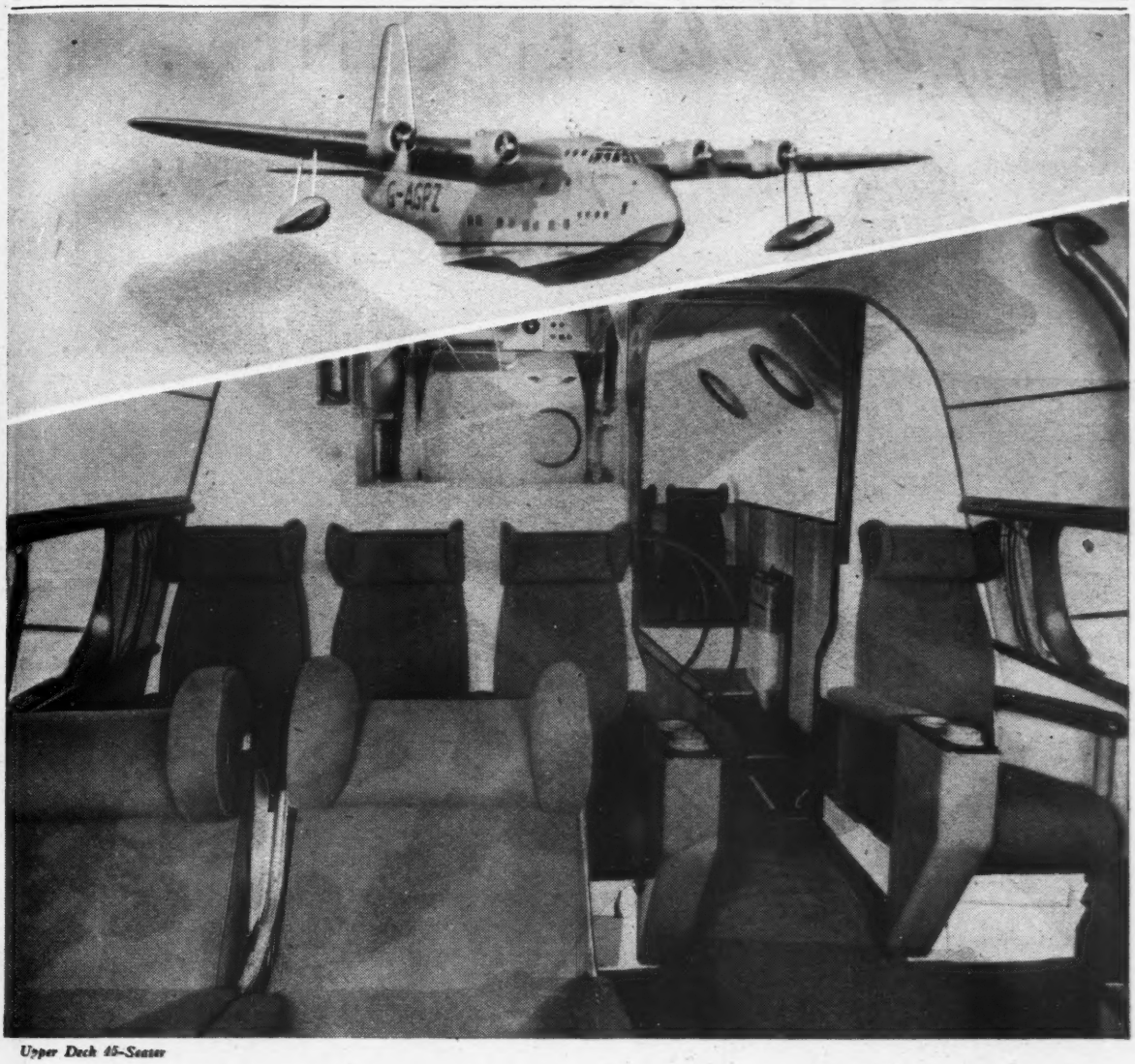


The de H Sea Hornet

S A N D R I N G H A M



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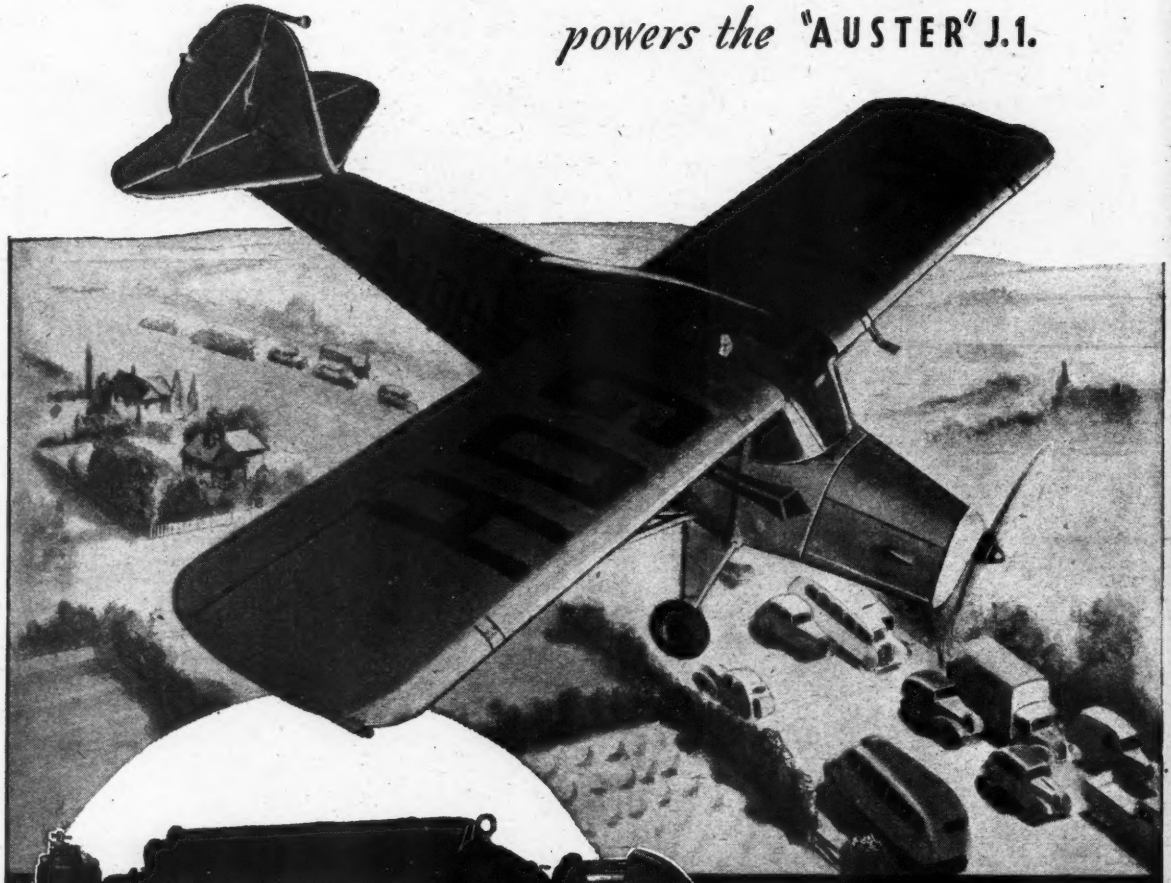
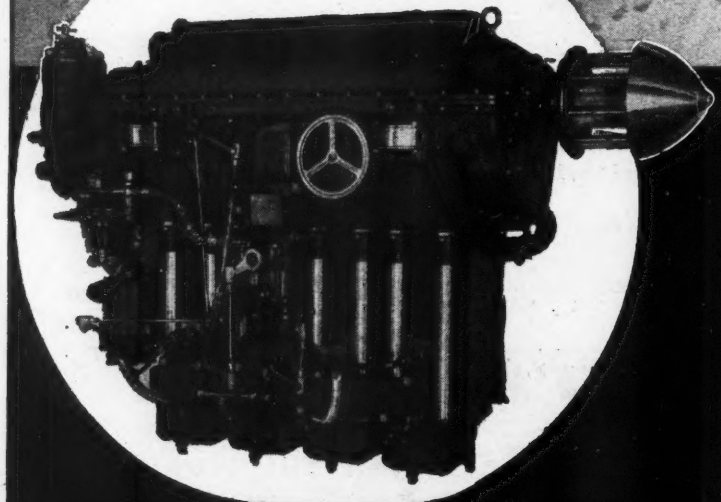
A *Cirrus* ENGINE...

powers the "AUSTER" J.1.





The Auster J.1 with Cirrus 'Minor' is a three seater of exceptionally good take-off, climb and landing performances. Loaded to 1,700 lb., it takes off in a 5 m.p.h. breeze in only 150 yds. The landing run is under 100 yds. (stalling speed with full flap 25 m.p.h.). Cruising speed is 100 m.p.h., top speed 120 m.p.h. Grass landing strips of 400 yds. are ample.

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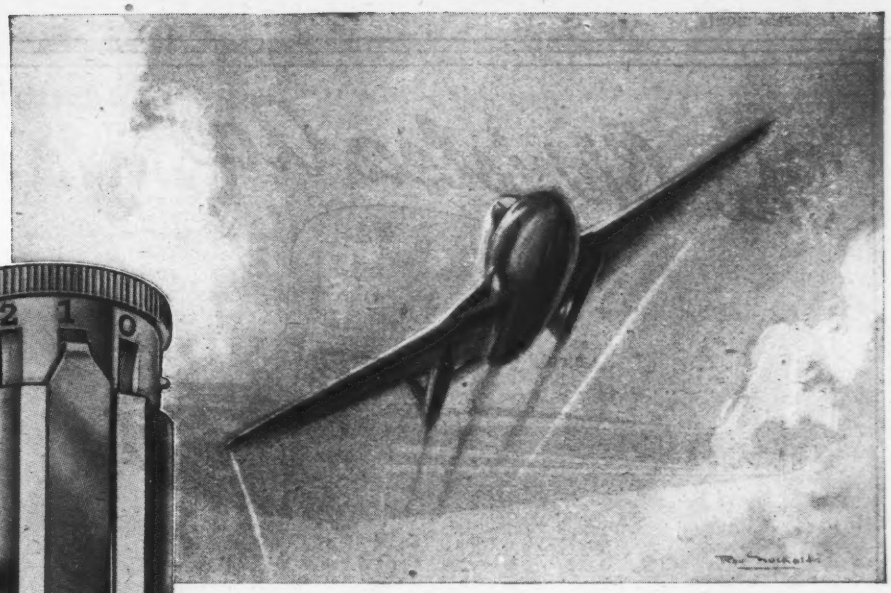

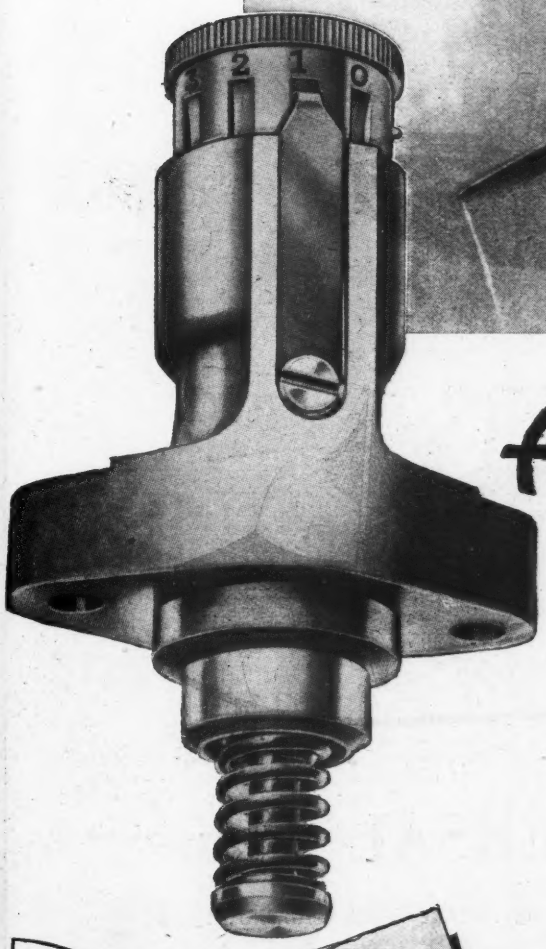

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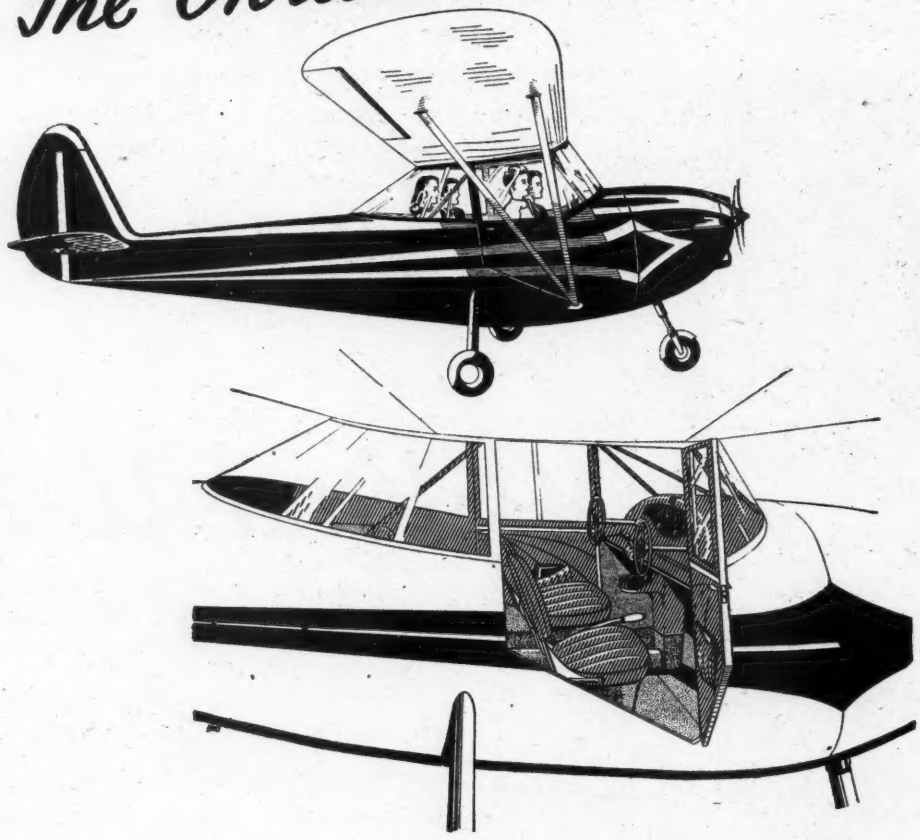

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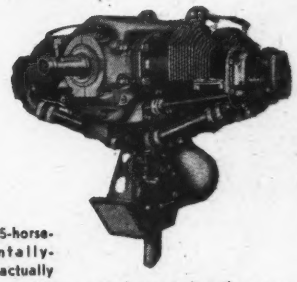
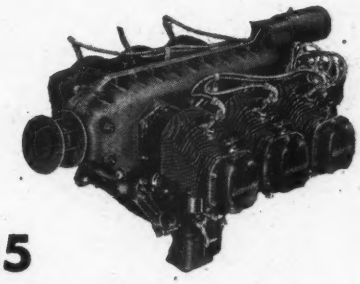


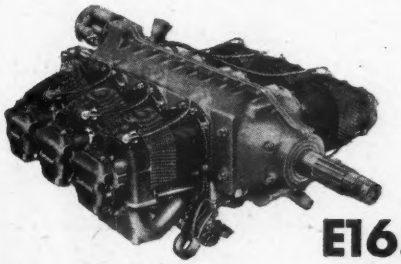
A65

This 4-cylinder, 65-horsepower, horizontally-opposed model actually powers more personal-type aeroplanes today than any other engine. It is the improved and refined descendant of the history-making Red Seal "A" series engines. Dominant in its field, it stands for satisfaction in aeroplane ownership and operation. Other 4-cylinder engines are made in the 75- and 85-horsepower range.



C115

The C115 is a 6-cylinder horizontally-opposed engine, of superb quality and outstanding performance for personal plane needs. The high ratio of horsepower to weight in Red Seal engines is illustrated by the fact that the dry weight of this 115-horsepower engine is only 256 pounds . . . and it delivers its full rated horsepower at 2350 R.P.M. There are also Continental 6-cylinder engines of 100 and 125 horsepower.



E165

The E165, one of the most highly engineered units in the Red Seal line, has been refined to meet the power requirements of high performance personal planes. It develops its full rated 165 horsepower at 2050 R.P.M., with a dry weight of 325 pounds. A 185-horsepower model is also in production.

Four and Six Cylinder Engines With Range of 65 to 185 Horsepower Now Available for Delivery

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Continental engines are standard equipment in more than 90% of the personal planes being manufactured throughout the world.

Continental engines are now being installed in the Auster Aeroplanes built by Taylorcraft Aeroplanes Ltd., of England.

Cub Aircraft Corporation of Canada, Fleet Aircraft Ltd., and Noury Aircraft are building Continental-powered planes. In the U.S.A. most personal planes including Piper, Aeronca, Swift, Taylorcraft, Beech, Culver, Cessna, Ercoupe, Luscombe, Commonwealth and many others have Continental engines, as does the Beech medium-power craft for executive and feeder-line use.

Write today for complete information on Continental Red Seal aircraft engines.

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Red Seal
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CONTINENTAL

Continental Motors Corporation
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IT'S all very fine to urge the workers to work harder for the sake of the Old Country; and urge management to step up production whether it can get the labour or not. But how, how, how? Well a man told us that he knew a Production Chief who had actually performed the miracle. He replaced all hand tools on the assembly lines with some small power tool or other. He said the result was marvellous. Bottlenecks disappeared, production skyrocketed; the workpeople came to work early because they liked the new power tools so much, and stayed late because the Management threw a Mutual-Congratulation Party in the canteen. He said everyone worked happily ever after just like in a fairy story.

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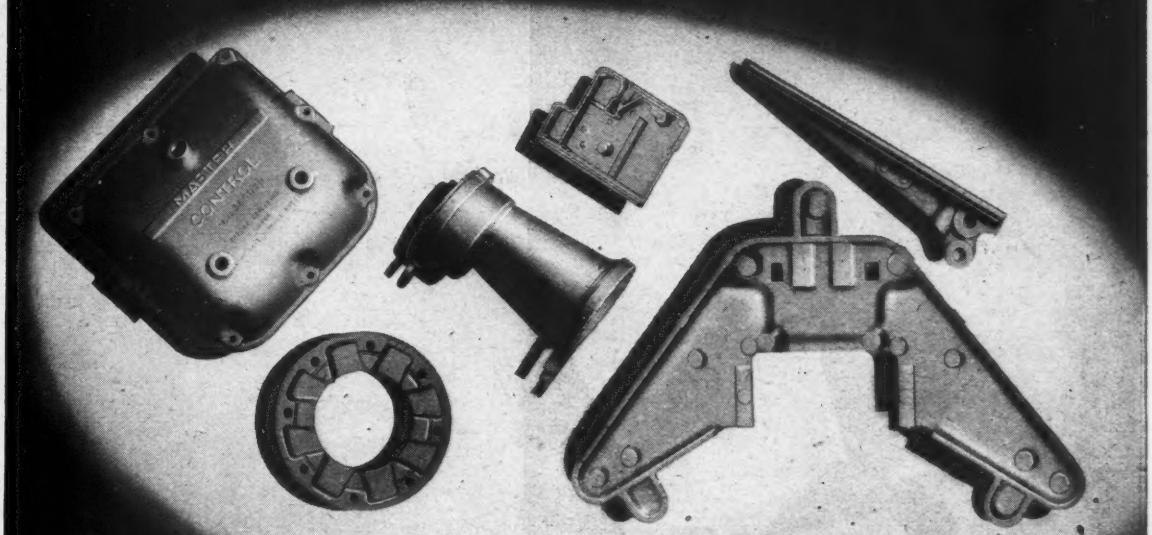
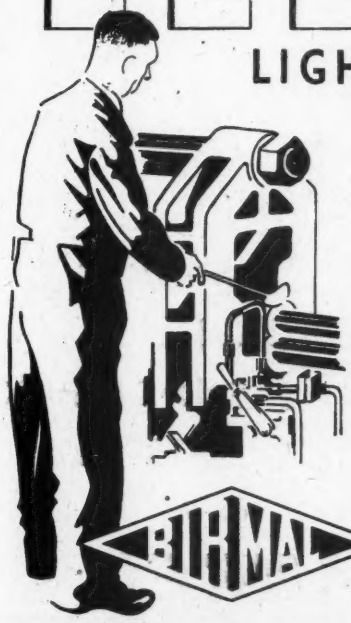


ELEKTRON

LIGHTEST OF THE LIGHT ALLOYS



The lightest of the light alloys, Elektron (magnesium), is now available in pressure die cast form. Thus this modern metal —allied to the most modern method of production—provides a welcome addition to the new materials for light engineering. Accuracy of form and smoothness of surface eliminate most subsequent machining operations. Soundness of casting and high strength/weight ratio are assured. Therefore, wherever weight is to be saved it is a real economy to specify pressure die castings in Elektron . . . made by Birmal.

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Which would You choose?

Put yourself in the shoes of the man about to buy an air passage ticket, who—with many like him, we fondly hope—is going to make air transport a success. Forget for the moment that you are an aviation enthusiast, keen to appreciate the lovely lines of an aeroplane and able to say "She looks right!" even before the first test flight.

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One is attractive and cool-looking with satin smooth Titanine surface in the characteristic house colours of a reputable air line. The other, picking up the sun's direct rays and reflecting them from glinting and rippled surfaces into your smarting eyes, looks — unfinished.

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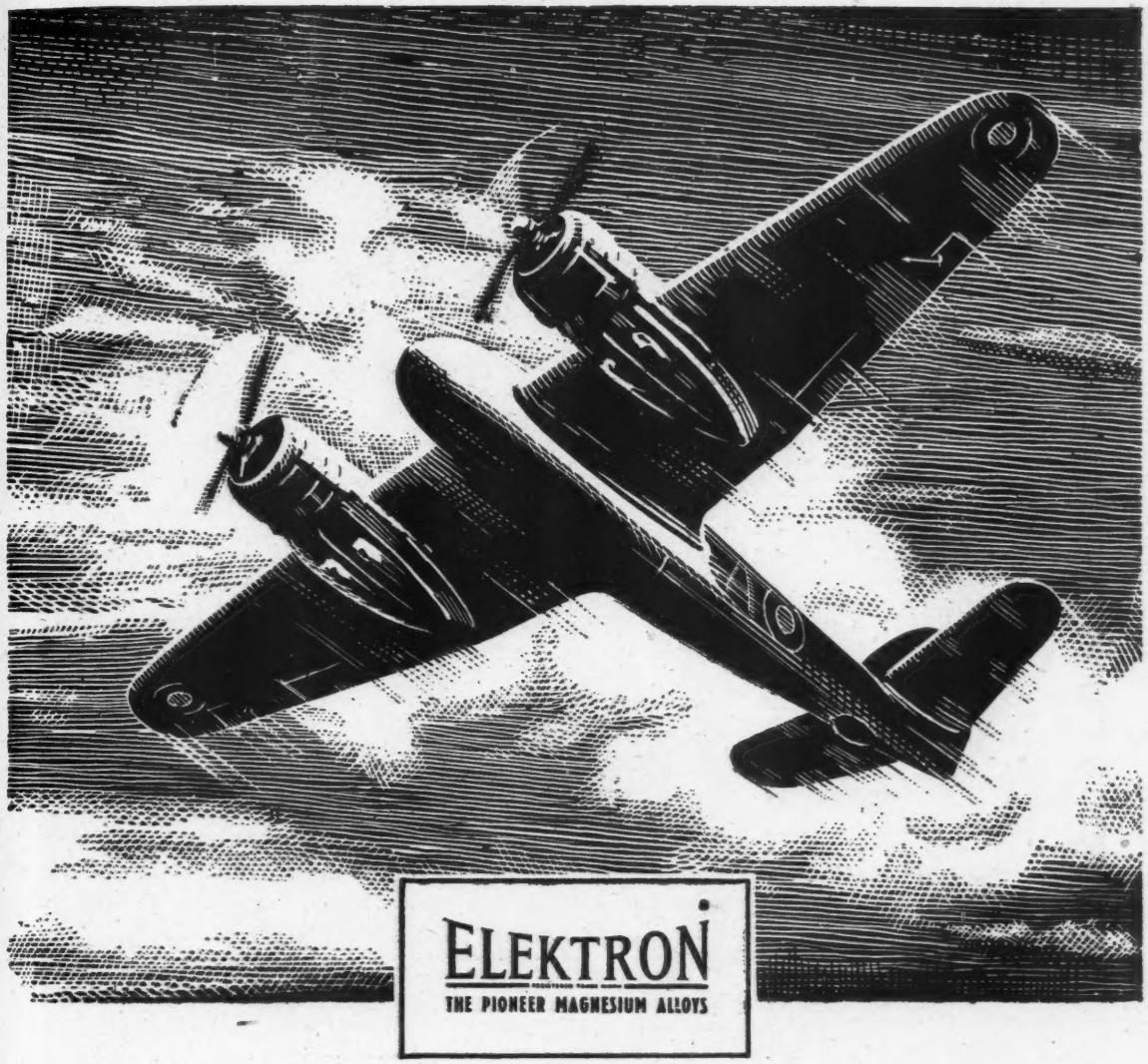

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FIRST AERONAUTICAL WEEKLY IN THE WORLD : FOUNDED 1909

Editorial, Advertising and Publishing Offices: DORSET HOUSE, STAMFORD STREET, LONDON, S.E.1
Telegrams: Flightpres, Sedist, London. Telephone: Waterloo 3333 (50 lines.)

COVENTRY: 8-10, CORPORATION ST. Telegrams: Autocar, Coventry. Telephone: Coventry 5210.
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Registered at the G.P.O. as a Newspaper

No. 1955. Vol. XLIX. June 13th, 1946 Thursdays, One Shilling.

The Outlook

A Great Truth

TOWARDS the end of his Wilbur Wright Lecture, the concluding instalment of which we publish this week, Mr. Relf pleaded urgently for increased research facilities. No one who has even a glimmering of the almost unlimited possibilities of future progress can fail to agree wholeheartedly with that plea.

During the war there was no time for what Mr. Relf called the "leisurely but very hard thinking which constitutes the research method," and, as he said, we have been left with a surfeit of ideas that could not be thought out in detail, and the implication of which will involve a lot of work by a lot of men.

The lecture made it very clear in which particular directions new equipment is needed if this country is to take a worthy position in aeronautical science. Not only do we badly want new and larger high-speed wind tunnels, but an extension of free-flight testing methods with supersonic models, not to mention the most difficult of all: full-scale flight. This latter cannot be undertaken with safety until a number of problems have been elucidated by the use of tunnel and free-flight models.

After every war there is always a cry for cutting down expenditure. The slogan of the politicians is usually "retrenchment and reform." After the first world war the "Geddes Axe" got to work. This time the picture is very different, but the difficulties with which the nation is faced are greater in many ways than they were in 1919 and onwards.

In the air world uncertainty reigns. No one can foresee just how things are going to shape. Consequently we cannot plan for large-scale production of any particular type of aircraft or engine. But we can and must devote every penny that can be spared to the development of new ideas. Not only must Government research establishments be well supported so that their equipment may be of the best, but the firms in the aircraft industry must be helped to contribute their share. As Mr. Relf said, there will have to be a lot of work by a lot of men, and British aircraft firms have many "back-room boys" who should be given the opportunity to contribute their ideas and thoughts to the common fund. In short, the one thing on which the nation cannot afford to be niggardly is aeronautical research, using the word in its widest sense.

During the inter-war years, quality rather than quantity had to be our watchword. In a somewhat different way the same must apply now. No one can be sure of what the future holds in the way of war or peace. The only way in which we can be prepared for whatever may come is to be in the very forefront of the world's aeronautical science.

Can Flying be made Simpler?

THIS week's issue, as it happens, deals with two aspects of flying which are just about as far apart as could be imagined. Mr. Relf discusses the problems of how fast man can fly, and at the other end of the scale we have an American designer and our own "Indicator" pondering the possibilities of simplified flying for the private owner who will, presumably, be flying very slow types of aircraft.

Some weeks ago we commented on some remarks by "Kibitzer" about the need for making flying easier. He wanted, as so many have done, to make the piloting of an aircraft as simple as the driving of a car. We, on the other hand, do not believe that to be possible, at least with any type of aircraft in sight at present—including the helicopter. But we do believe that something can be done to make the flying-control movements more instinctive than those which have become universally accepted.

Readers will observe that "Indicator" is somewhat lukewarm about the possibilities, while Mr. Gwinn is, to our way of thinking, asking a little too much. But then "Indicator" has had very long experience with

orthodox controls and has reached that happy stage where the control actions have become instinctive. He has probably by now forgotten the clammy hands and nervous exhaustion which attend the initial efforts of all beginners.

In February of last year we published a paper by Mr. F. E. Weick, an American designer who has evolved the Ercoupe two-control aircraft. That machine went through a fairly searching test at American flying schools, and in the main it appears to have proved that its inability to use its rudders as yaw correctors or inducers of sideslips was not a serious drawback.

The crux of the matter appears to be in the two-control idea. The skilled pilot wants his rudder control to be available for slipping-off drift just before the touch-down. The tricycle undercarriage should be capable of looking after any reasonable amount of drift, and the problem seems to resolve itself into a question of whether or not the number of mishaps caused by the absence, in the two-control system, of an independent rudder control is likely to be greater than those resulting from mishandling the present three-control system. We should rather doubt it, and the results are not likely to be so serious.

The Price of Victory

THE White Paper on the strength and casualties of the Armed Forces, auxiliary services, and civilian casualties during the war, issued last week, discloses the grievous losses suffered by the United Kingdom during the war. Out of a total of 5,896,000 in the Armed Forces, we lost 264,443 killed. The death roll in the women's auxiliary services, the Home Guard, the Merchant Navy and the Fishing Fleet brought this figure up to 296,521. In addition, more than 60,000 civilians were killed, bringing the total up to 357,116.

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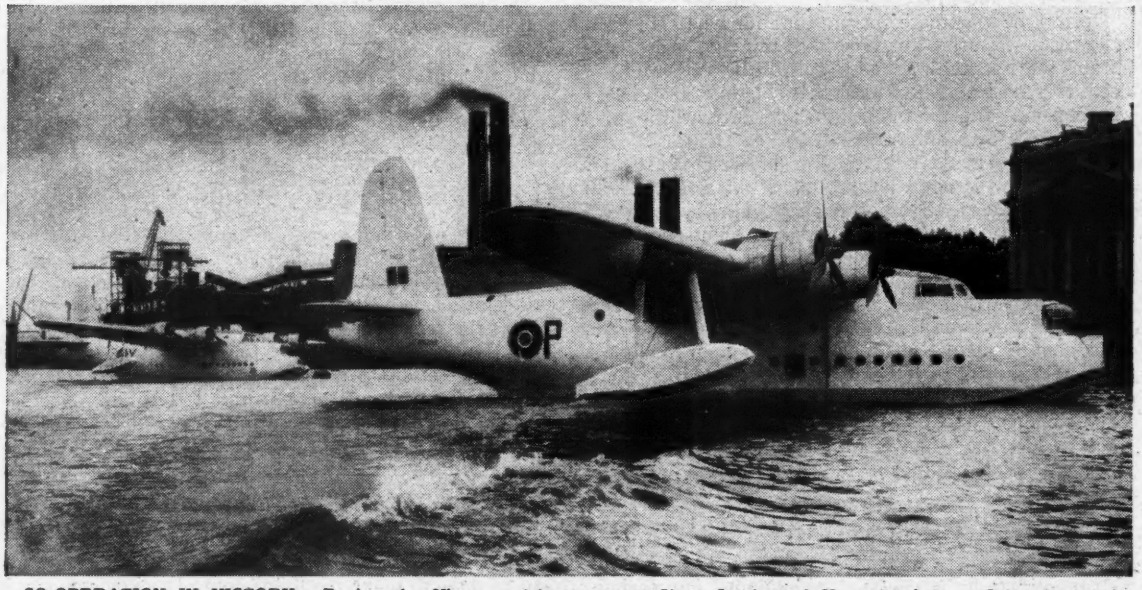
Total casualties amounted to 950,794, of which the Navy suffered 73,642, the Army 569,501, and the R.A.F. 112,296. These figures, when related to the strengths of the three Services, show how dearly the Royal Air Force payed for its magnificent work, first in establishing supremacy in the air during the Battle of Britain, and afterwards in bringing Germany to impotence by bombing and in many other ways.

Even the figures do not convey the whole picture, for Royal Air Force personnel were the cream of our youth, and their training period was much longer than that for the other two Services. There is some consolation for their loss in the fact that the total number killed in this war was about one-third of the corresponding figure for the 1914-18 war, and for that we have, in a very large measure, the Royal Air Force to thank. It paid the price, and paid it gladly, but we should not be worthy of the men of the R.A.F. if we ever forgot what we owe to them.

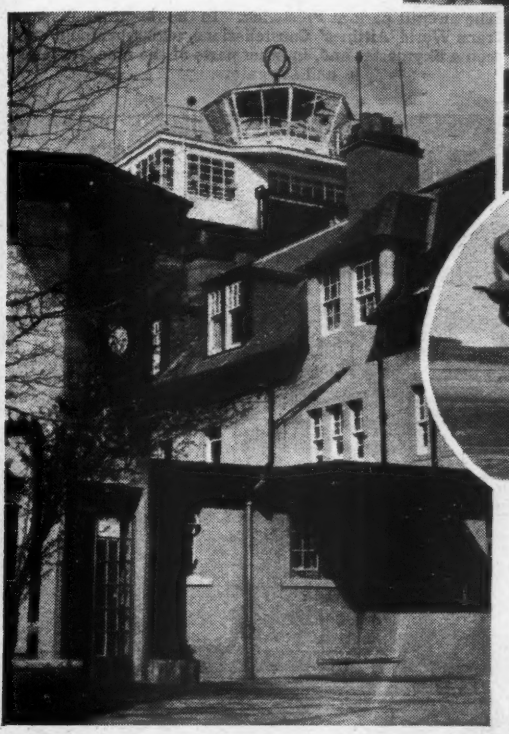


CO-OPERATION IN VICTORY: During the Victory celebrations two Short Sunderland V reconnaissance flying boats of No. 230 Squadron were open to public inspection at Greenwich. They are seen above soon after arrival. The Sunderland V has four Pratt and Whitney Twin Wasp engines and heavier armament, but is otherwise similar to the Pegasus-engined Mk. III. Riding near the Naval College in company with *Bellona* and *Diadem*, two of our latest cruisers, they symbolize Coastal Command's wartime co-operation with the Royal Navy. No. 230 Squadron left its base at Pembroke Dock for the East in 1938 and did not return until April this year. After equipping with Sunderlands the squadron was engaged during the war on anti-submarine patrols at Singapore, Ceylon, in East African and in Mediterranean waters. It also took part in the evacuation from Crete and did supply and ambulance duties for General Wingates expedition.

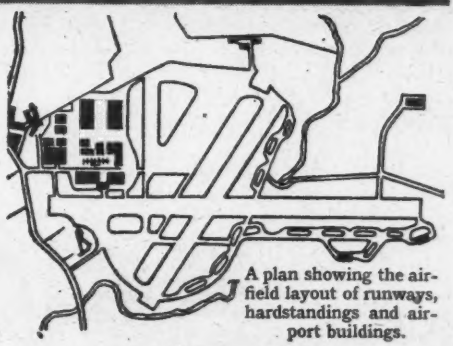
PRESTWICK AIRPORT

Scotland's International Airport: Good Facilities for Passenger and Aircraft Handling

(Right) A general view of the airfield looking down the main runway from the south east. The town on the extreme left is Prestwick.



(Above) A Lancastrian of Trans-Canada Air Lines arriving at Prestwick from Dorval on the regular scheduled service. (Left) The entrance to the airport hotel from the airfield. The control tower forms a part of the hotel and terminal building.

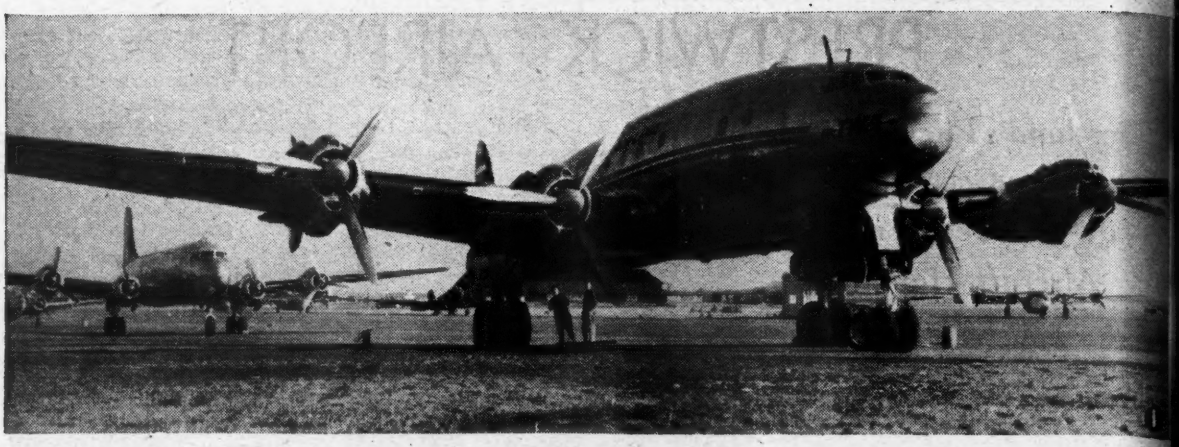


A plan showing the airfield layout of runways, hardstandings and airport buildings.

OF recent months, Prestwick has been very much in the news—chiefly because of the long-continued controversy concerning its suitability as an international airport. As in many such controversies, however, the arguments on one side seem to be mainly based on a false premise—namely, that Prestwick should be considered as an alternative to the London Airport, Heathrow, as the international airport for the United Kingdom. In fact, the real question is not whether Prestwick should be regarded as the international airport for the United Kingdom, but simply whether it should be officially regarded as an international airport for Scotland.

Unquestionably, Prestwick is an airport with excellent facilities, with outstandingly good weather record, and with ample potentiality for expansion when and if necessary. Apart from its good approaches and runways—the main one is 2,200 yards long and the secondary runway is 1,600 yards long—Prestwick has considerable hotel accommodation on the airport itself, good terminal facilities, and an aircraft factory offering full servicing facilities alongside the airfield. If one adds the weather record to these other assets, there is certainly a strong case in favour of maintaining Prestwick as Scotland's main international air terminal—and, in fact, it has already been so designated by the Minister of Civil Aviation.

As is generally known, the airport is situated on the west coast of Scotland a little north of Ayr, and is within easy distance of the industrial, commercial and more highly populated areas of Scotland around the Forth and the Clyde. Regarded internationally, it is also well located for the transatlantic flight to Canada and the U.S.A., and even for routes into the more northerly



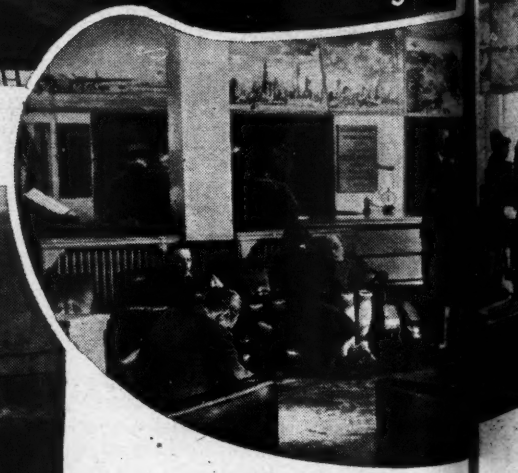
countries of Europe and Asia when great-circle long-distance flying courses are being considered.

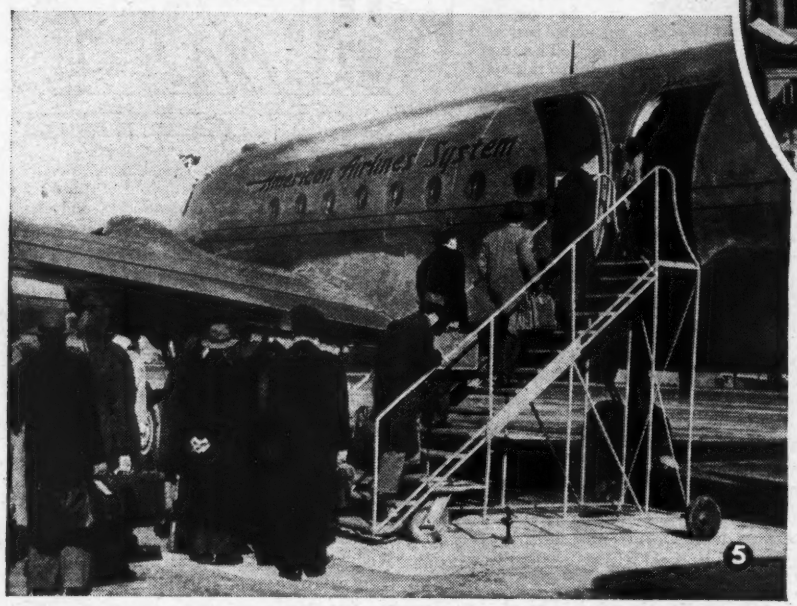
One is apt to regard Prestwick airport primarily as a wartime development, and it is, of course, true that during the greater part of the war it played, with its facilities, a vital role both as a North Atlantic air terminal and a delivery point. However, the original airfield was very much pre-war. In fact, the idea of laying out such an airfield was first conceived in 1935 by the Duke of Hamilton and Grp. Capt. D. F. McIntyre at the time of their flight over Mount Everest, and it was due to their efforts that the site of Prestwick was finally selected.

PRESTWICK AIRPORT

In the earlier days of its history it was a small grass airfield used for training purposes, an E.F.T.S. having been started there before the war. When, in 1940, Lord Beaverbrook, who was then Minister of Aircraft Production, took the decision to fly new aircraft across the Atlantic on delivery from the U.S.A., Prestwick was the airfield selected for use at the end of the route. It was then that the Ferry service—A.T.F.E.R.O.—

1. The aircraft park at Prestwick. In the foreground is one of Trans World Airlines' Constellations, whilst behind it can be seen a Skymaster and, in other parts of the area, Dakotas and Liberators.



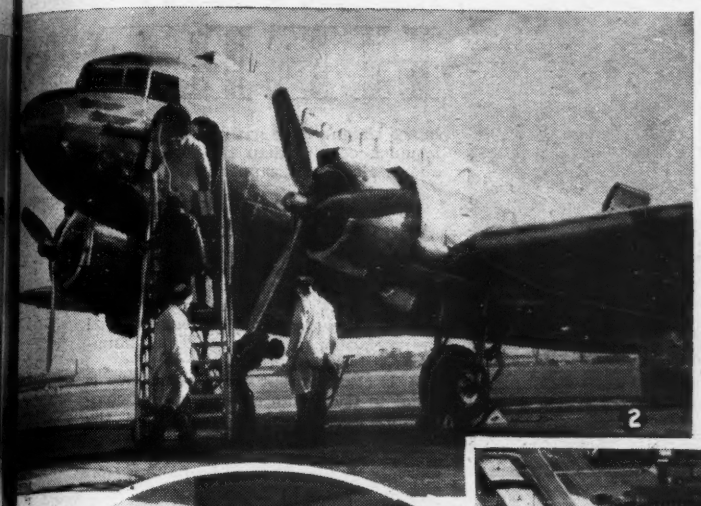


3. A K.L.M. Skymaster on the recently inaugurated "Flying Dutchman" service which calls at Prestwick on its way between Amsterdam and New York.

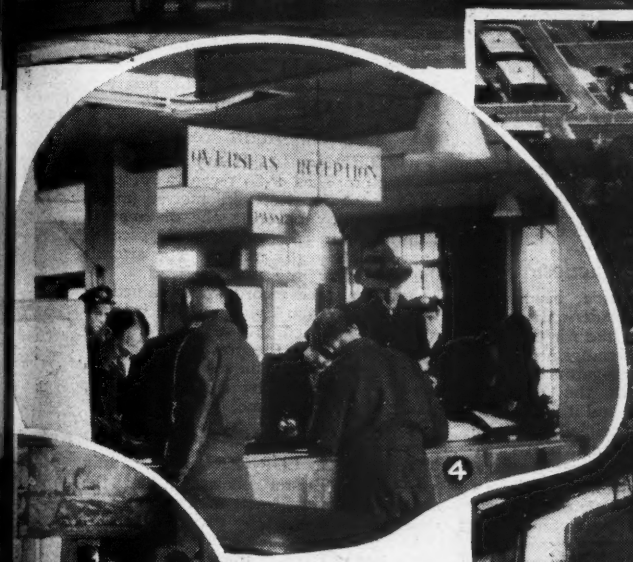
4. Passengers at the reception desk in the airport hotel.

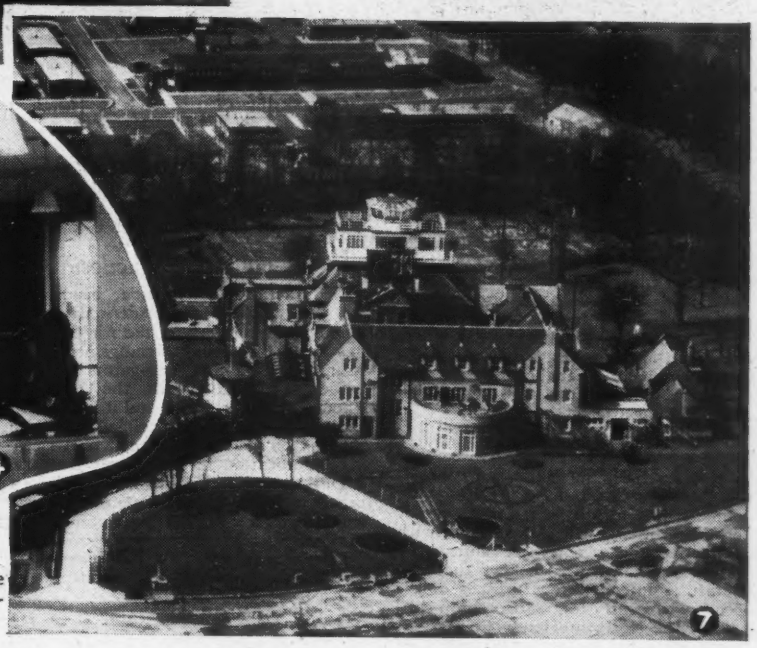
5. Passengers embarking in an American Overseas Airlines' Skymaster bound for New York.

6. The airport hotel's comfortable terminal hall in which passengers await the call to their aircraft.



2. One of Scottish Airlines' converted C-47s which are in operation on the Prestwick to Belfast, and on the Reykjavik to Copenhagen via Prestwick routes. These aircraft were converted to full passenger standard by Scottish Aviation.





7. A general view of the airport, hotel and terminal building.

came into being and, as the ferrying commitment grew, so the expansion of the airfield became essential and was put into effect. The most notable improvement, of course, was the construction of the runways, which was undertaken in 1941 upon Lord Beaverbrook's direction, with, in addition, the provision of adequate factory accommodation for the assembly of lend-lease aircraft.

Prestwick was used continuously by American airline operators between May, 1942, and September, 1945. In addition, B.O.A.C. have been using it as a terminal for their Return Ferry service which, until the end of April this year when the service was partially re-routed, had completed over two thousand North Atlantic crossings between Montreal and Prestwick during the five and half years of its operation.

Another airline using it as a terminal is Trans-Canada Airlines, which first began to operate its transatlantic service to Prestwick in 1943. In September last year, the T.C.A. service was opened to fare-paying passengers, and it now runs five times weekly in both directions, using Lancastrians. Soon the schedule is to be stepped up to a daily frequency and, before the end of the year, will operate with the Merlin-engined DC-4s.

Linked, in a sense, with these transatlantic services is the R.A.F. Transport Command's "Prestwick-Blackbushe Shuttle," which functions regularly each day, irrespective of weather, bringing transatlantic passengers for London within a 1½ hours' coach run of their destination.

Another transatlantic service which now uses the airport is the K.L.M. "Flying Dutchman," which was inaugurated on May 21. It operates Skymasters between Amsterdam and New York, via Prestwick, and is running to a three times weekly schedule.

In addition to the transatlantic services, the airport is also used by services run under charter by Scottish Airlines, notably that between Prestwick and Belfast, and a new service between Copenhagen and Reykjavik via Prestwick which started at the beginning of this month. The aircraft used are C.47s (alias Dakotas) which have been converted by Scottish Aviation in their own factories at Prestwick. Another new route will open on July 17, when Air France will run the first service of a direct thrice-weekly schedule from Paris.

There is no doubt that, at the moment, as can be seen from the accompanying photographs, Prestwick has excellent buildings and facilities for handling passengers and aircraft. The airport's future, however, in common with that of our other airports, is now in the hands of the Minister of Civil Aviation. What his ultimate plan may be for Prestwick is not yet clear, but a few days ago B.O.A.C. notified their intention of routing, eventually, two Constellations a week through the airport

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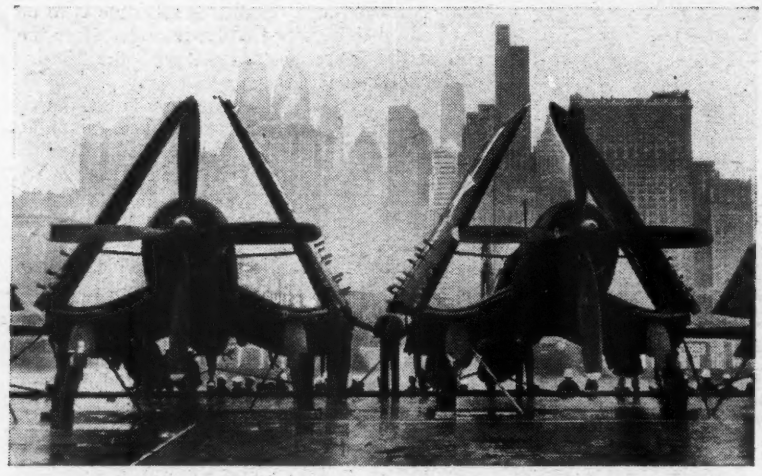


SKY-SCRAPERS : The aircraft carrier, *Franklin*, flagship of the U.S. 8th Fleet, steams up the Hudson River with the New York skyline seen beyond her neatly parked Corsairs on the flight deck. The weather doesn't look too good.

New Helicopter Project

WORK will shortly begin on a new helicopter designed by the Cierva Autogiro Co., Ltd., and to be built under licence at the works of Cunliffe-Owen Aircraft, Ltd.

An official statement to this effect has been made jointly by the two firms concerned, and the Cunliffe-Owen concern has placed facilities at the disposal of the Cierva company to enable them to continue research and development work on rotating-wing aircraft.

Northrop Turbines

AN order from the U.S.A.A.F. for fifteen Northrop XB-35 flying-wing bombers has already been announced. Certain of these will be powered with turbine-jet and airscrew-jet units, and there is good reason to believe that one aircraft is intended for turbines developed by a recently formed Northrop subsidiary, the Northrop-Hendy Co.

According to *American Aviation* this company has been organized on a fifty-fifty basis with the Joshua Hendy Co.

Indian Aircraft Industry

SOME two months ago an aircraft mission from the United Kingdom visited India to survey the potentialities for aircraft manufacture, and on its recommendation the Indian Government is to establish its own industry. Starting with the production of trainers for the Royal Indian Air Force, at the Government-owned aircraft repair factory at Bangalore, the cost of the scheme will not exceed £975,000 in the first five-year period and aims at complete self-sufficiency in 20 years. The first trainer is expected to appear within 18 months.

Training in S. Rhodesia

AN Air Ministry Mission, headed by Air Marshal Sir Roderic Hill (the member for training on the Air Council) has been discussing arrangements for training pilots and navigators for the peacetime R.A.F. with the Southern Rhodesian Government, and it is reported that "agreement in principle" has been reached on the establishment of a training organization in that sunny country.

During the war, 8,500 British aircrew pupils were trained in Southern Rhodesia which earned a reputation not only for the high standard of training given, but for the very friendly hospitality extended by its residents to R.A.F. pupils.

Flying Oysters

SINCE the day when a young pioneer pilot with a strong sense of humour —his name was Moore-Brabazon—took a pig up for a short "flip" just to knock the bottom out of a popular saying, there have been many queer cargoes carried by air.

The latest, and surely one of the most unusual of all, is a consignment of 500 live Falmouth oysters bound for Johannesburg on the "Springbok" service operated jointly by B.O.A.C. and South African Airways.

Altogether, 3,000 oysters are to be flown to South Africa by arrangement with the Government there, in an attempt to improve the oyster industry in the Union. The native African oyster is much coarser than the English kind and is also fast disappearing.

Flat-four C.I. Engine

A 125 h.p. opposed four-cylinder air-cooled compression-ignition engine has been designed and built by Mr. Fred Thaheld in America and installed in a Stinson 110. Flying the aircraft himself, the designer recently demonstrated the performance at Long Beach Municipal Airport.

It is claimed that the performance is equal to that of an aircraft with a comparable petrol engine, except that the climb is rather better.

The engine's principal selling point, however, is its fuel economy, and a consumption figure of three gallons of diesel oil per hour is quoted. The capacity is 290 cu in and the weight 235 lb.

Two American Records

PILOTED by Lt. Henry Johnson, a jet-propelled P-80 recently set up a new record for 1,000 kilometres (about 625 miles) by covering the distance in 1 hr 20 min 31 sec, giving a speed of approximately 462 m.p.h. The aircraft did not carry any military load.

Another speed record was obtained by Lt. Keith Wilson flying an R-5 helicopter. He recorded 110 m.p.h. over a 20 kilometre course, the previous helicopter record officially achieved being 76.15 m.p.h. established by a German pilot, Ewald Rholfs, in June, 1937.

Hunting Display

"AVIATION CORNER" in Piccadilly (the Bristol showroom at the corner of Dover Street) might almost be described as a non-stop variety show.

Last Tuesday it "opened with a new act" in the form of the Hunting Group display which represents all that group's many aeronautical interests—Percival's, Hunting Aerofilms and Aerosurvey, Air Travel, Field Consolidated, and so forth.

Centre of attraction are scale models of the Merganser and Proctor rigged up for survey work, with aerial photographs unfolding beneath them.

The Old Firm

MR. NORMAN GIROUX must have been one of the first of the many post-Great War "joy-riding" exponents who did much to popularize flying in this country during the early nineteen-twenties, mostly with Avro 504Ks and similarly venerable types.

For the modest fee of a few shillings, hundreds of Britons saw their own towns from the air for the first time and dis-

AIRSTRIP . . . . No. 18

&THERE

covered that flying definitely "had something."

Up at Southport it was Norman Giroux who introduced so many of the local residents and holiday visitors to a plan view of the seaside, and now he's back on the job again, but with a couple of rather more up-to-date "kites"—or he will be as soon as his allocation of fuel for 60hr a month materializes.

News in Brief

AIR COMDRE. FRANK WHITTLE, it was announced last week, is to continue in the service of the Ministry of Supply as technical adviser on engine design and production to the Controller of Supplies (Air).

* * *

Reuter reports from Oslo that three of the seven four-seater Beachcraft bought in Britain by the new Sandsfjord Airways Co., were flown to Norway from Croydon last week.

* * *

R.A.F. passenger and troop-carrying aircraft flew 58,000,000 passenger-miles during the month of April and suffered one accident. This involved the deaths of two crew and nine passengers and injuries to three crew and one passenger.

* * *

A guard of honour consisting of 50 R.A.F. officers and men already drilled for the Victory Day parade was present at Northolt airport last week to receive Lord Louis Mountbatten, C.-in-C. S.E.A.C., Field Marshal Sir Claude Auchinleck, and Norwegian Chiefs of Staffs when they arrived by air.

* * *

Members of the Aero Golfing Society will again compete for the *Flight* Challenge Cup, first presented by the proprietors of the journal in 1923, at the Society's summer meeting to be held at St. George's Hill Golf Club, Weybridge, on Tuesday, June 18th. Lt. Col. W. A. Bristow, who won the last contest in 1939, also won the first 23 years ago.

* * *

A telegram was recently radioed from the Stockholm airport at Bromma to a Swedish DC-3 flying near Bombay, 3,875 miles away, and a reply received from the aircraft. This is claimed to be a long-distance record.

* * *

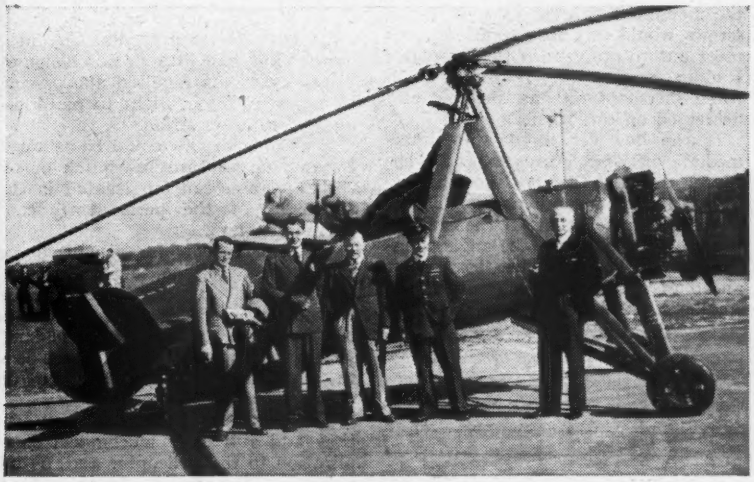
The Church of Sweden Mission is using a Dakota aircraft, *Ansgar*, in which to fly missionaries to their posts in various parts of the world. *Ansgar* recently landed at Bulawayo and disembarked three families bound for that area, and the rest of the 20 passengers were put down at Johannesburg.

* * *

British, American and French model flying clubs are expected to compete in the first international model flying contest since the war, which is being organized by the Model Aeronautics Council of Ireland at Baldonnel (military) airfield, Co. Dublin, on June 23rd. The Belfast and Ulster clubs, and two Dublin clubs are taking part, and there are classes for rubber- and petrol-driven types. The French and U.S. clubs will probably compete by proxy.

"Flight" photograph.

FLYING TEST BED: One of the Folland 43/37 monoplanes designed specially to flight test engines. This aircraft is at present being used by the engine division of the de Havilland Aircraft Co., Ltd.



DEMOBBED: Four C.30 autogiros, after six years' "special operations" with the R.A.F., were recently returned to the Cierva works at Southampton Airport to get their C. of A. for export and other civilian duties. Mr. C. G. Pullin, the firm's managing-director is on the extreme right of the four pilots (l. to r.) Messrs. Marsh, Theilman, Gillies and Harper.

Fourth Edition

GAS TURBINES and JET PROPULSION FOR AIRCRAFT

By. G. Geoffrey Smith, M.B.E.

A NEW edition of this book, greatly enlarged and profusely illustrated is now in the press. Twenty-one chapters cover the development of the aircraft gas turbine, in both jet and airscrew types, describe current and projected turbine-propelled aircraft, and discuss future prospects.

They deal with the functioning of gas turbines, the fundamental principles of jet propulsion, and the performance, testing and maintenance of turbine units.

Combustion systems, fuel and control equipment and turbine design features are fully described and illustrated by specially-prepared sectional drawings.

The relative merits of airscrew and jet propulsion under different operating conditions are assessed, and the influence of turbine power units on aircraft design is emphasized.

Special chapters outline the probable development of tailless and all-wing aircraft and discuss the problems of high speed flight, compressibility effects, and boundary layer control.

First published in 1942 when the significance of the gas turbine to the future progress of aviation was not generally appreciated, it was for long the only work on the subject. In subsequent years two further editions were published, but for some time these have been exhausted.

The work was widely adopted as the standard text on the subject by universities, technical institutions, and governmental and commercial training establishments. Two editions were also published in the U.S.A.

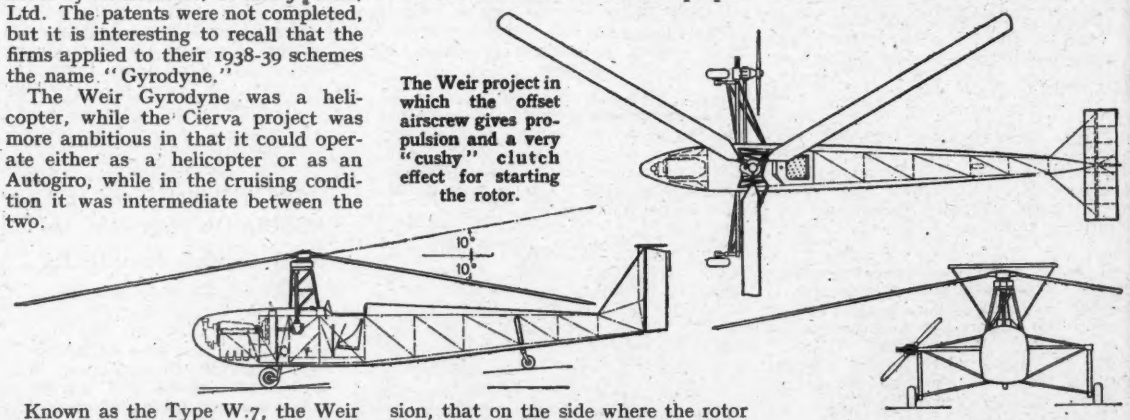
Copies of the fourth edition will be available in the course of a few weeks, price 12/6, from Flight Publishing Co. Ltd., Dorset House, Stamford St., London, S.E.1.

Gyrodynetics

Counteracting Single-rotor Torque, and an Intermediate Stage Between Gyroplane and Helicopter

THE relative simplicity of the single-rotor helicopter is attractive, but the problem of torque reaction is somewhat troublesome. Igor Sikorsky has shown that it can be controlled by a small airscrew at the tail, set with its axis at right angles to the line of flight. Other arrangements are possible, and two projects which were stopped by the war are of more than passing interest. One was provisionally patented by the Cierva Autogiro Co., Ltd., and the other by its licensees, G. and J. Weir, Ltd. The patents were not completed, but it is interesting to recall that the firms applied to their 1938-39 schemes the name "Gyrodyne."

The Weir Gyrodyne was a helicopter, while the Cierva project was more ambitious in that it could operate either as a helicopter or as an Autogiro, while in the cruising condition it was intermediate between the two.



The Weir project in which the offset airscrew gives propulsion and a very "cushy" clutch effect for starting the rotor.

Known as the Type W.7, the Weir project had as its most unusual feature an offset airscrew with its axis in the fore-and-aft direction, the thrust of this airscrew counterbalancing the torque-reaction of the rotor. There was, however, more in it than that. The engine was to drive, through a primary clutch, a mechanical differential gear which divided the torque evenly between the rotor and the airscrew. Yawing control was by brakes or clutches on the differential shafts.

An "Air" Clutch

In addition to this, however, the airscrew provided a secondary fluid (air) clutch effect by the difference of the moment of inertia between rotor and airscrew and the mechanical differential. For starting, the primary clutch was engaged, and the airscrew, driven through the differential, began to turn until it experienced an appreciable resistance from the air. As this resistance grew, torque would be smoothly and progressively applied to the rotor, which would speed-up until rotor and airscrew were taking the same amount of torque. Jump-starts would be achieved without any appreciable overspeeding of the engine.

In the Cierva project two airscrews were to be used for forward propulsion, that on the side where the rotor blades were advancing being permanently geared to the rotor, while that on the "retreating" side had a clutch mechanism so arranged that when the rotor clutch was engaged, the airscrew was disengaged, or vice versa. The idea was that if it was desired to fly the machine as a gyroplane, both airscrews would provide propulsion, the rotor autorotating as in the Autogiro. Rudder control was by pedal, pitch being increased on one airscrew and decreased on the other.

It was, however, in the stage intermediate between Autogiro and helicopter that the Cierva Gyrodyne displayed its greatest advantage. Things were so arranged that, at the cruising speed of the machine, the angle of incidence of the rotor disc to the air ahead of the rotor was positive and smaller than the downwash angle behind the rotor. In other words, the mean axial flow through the rotor disc was substantially zero. In that attitude the torque required is approximately equal to the torque needed to overcome the profile drag of the blades.

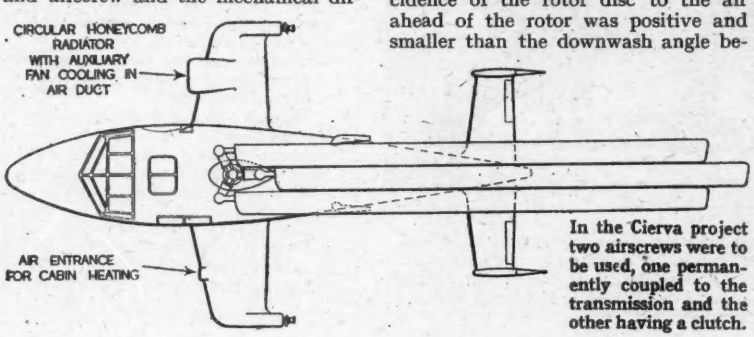
Minimum Drag

In addition, the slight backward inclination of the thrust vector of the rotor required a propulsive thrust, to be supplied by the airscrew, which also had to overcome the drag of the rotor in the plane of the rotor disc and, of course, the parasite drag of the whole aircraft. The torque input to the rotor would be lower than if it were operating in the pure helicopter condition, and a further advantage was that the pitch angle was within, or only just beyond, the maximum limit of the autorotative range. This meant that little or no change of pitch angle was required for passing from power-driven flight to motorless gliding in autorotation.

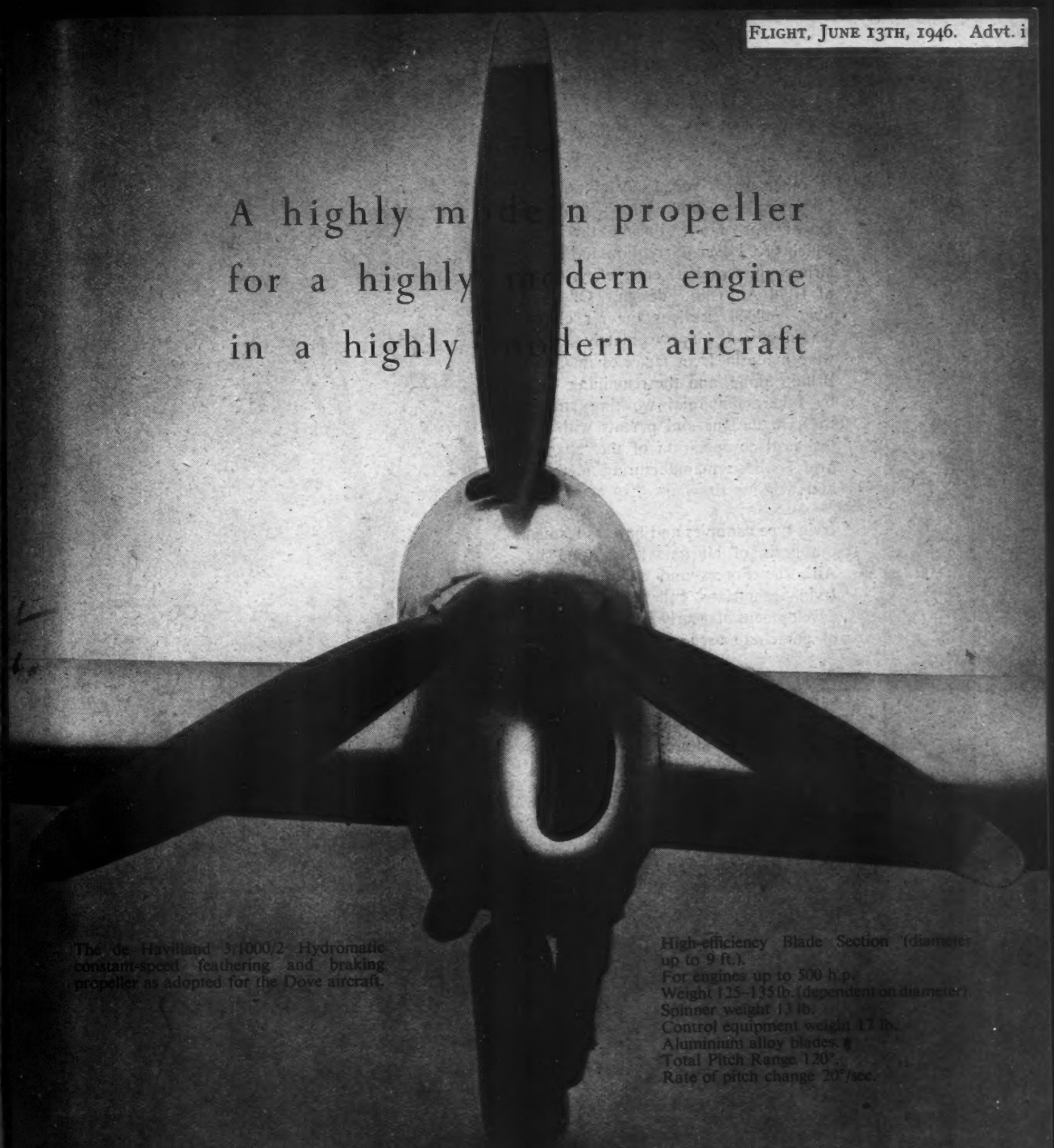
Trimming in yaw could be attained by varying the airscrew pitch or by the adjustable tail fin situated in the slipstream of the permanently connected airscrew.

Of other refinements visualized for the Cierva Gyrodyne, mention may be made of a governor for controlling the mean pitch angle of the rotor blades and keeping rotor speed constant. This was to operate very much as does the hydraulic mechanism of the de Havilland constant-speed airscrew.

Interesting as these two projects are, they add still more mechanical complication to the helicopter and, as we pointed out in a leading article recently, it seems rather a pity that the gyroplane has been dropped entirely. Jump-start versions gave nearly all the advantages of the helicopter and were relatively simple.



In the Cierva project two airscrews were to be used, one permanently coupled to the transmission and the other having a clutch.



A highly modern propeller for a highly modern engine in a highly modern aircraft

The de Havilland 3/1000/2 Hydromatic constant-speed feathering and braking propeller as adopted for the Dove aircraft.

High-efficiency Blade Section (diameter up to 9 ft.).
For engines up to 500 h.p.
Weight 125–135 lb. (dependent on diameter)
Spinner weight 13 lb.
Control equipment weight 17 lb.
Aluminium alloy blades.
Total Pitch Range 120°.
Rate of pitch change 20°/sec.

DE HAVILLAND

high-efficiency

PROPELLERS

DH PROPELLERS

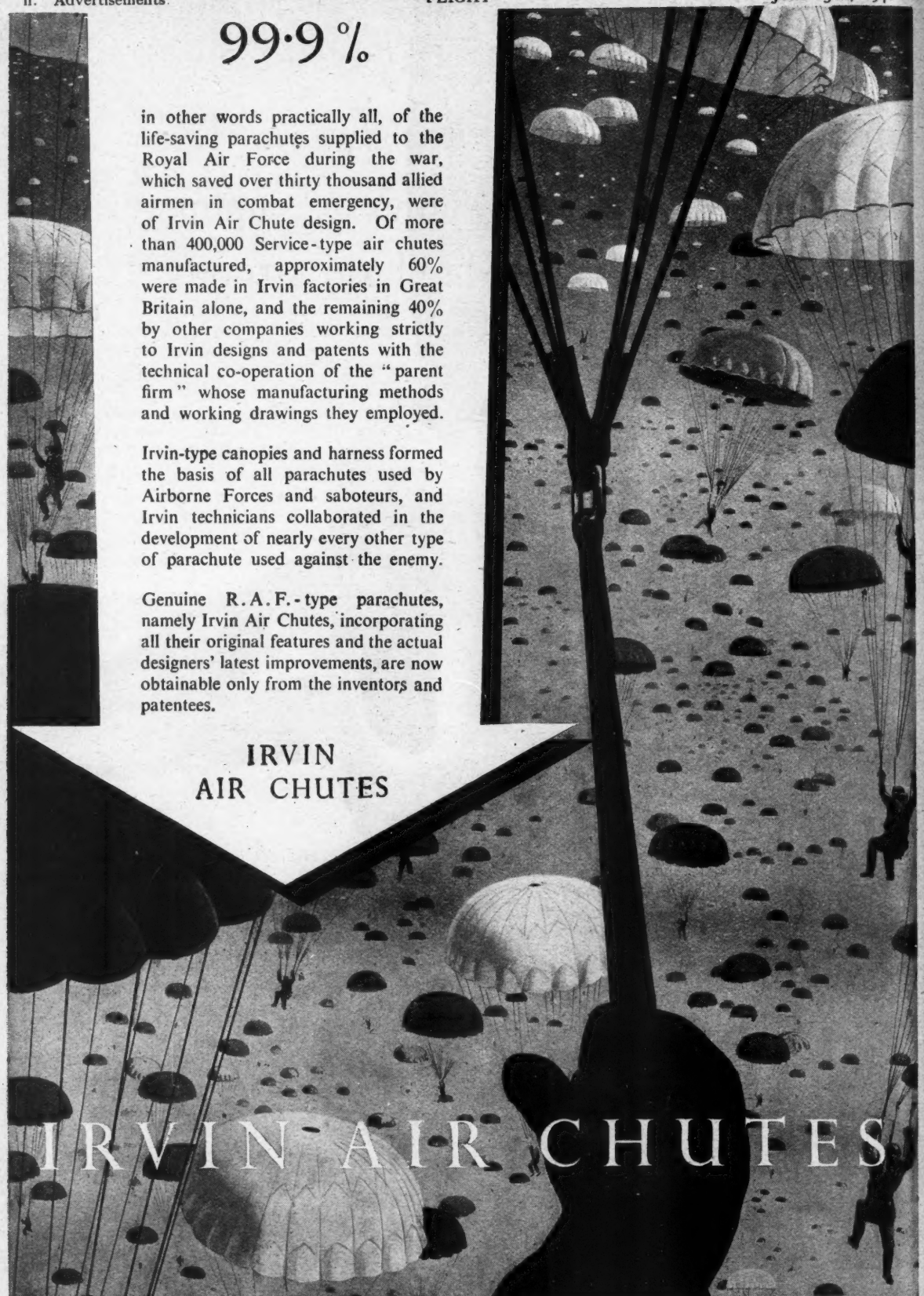
99·9 %

in other words practically all, of the life-saving parachutes supplied to the Royal Air Force during the war, which saved over thirty thousand allied airmen in combat emergency, were of Irvin Air Chute design. Of more than 400,000 Service-type air chutes manufactured, approximately 60% were made in Irvin factories in Great Britain alone, and the remaining 40% by other companies working strictly to Irvin designs and patents with the technical co-operation of the "parent firm" whose manufacturing methods and working drawings they employed.

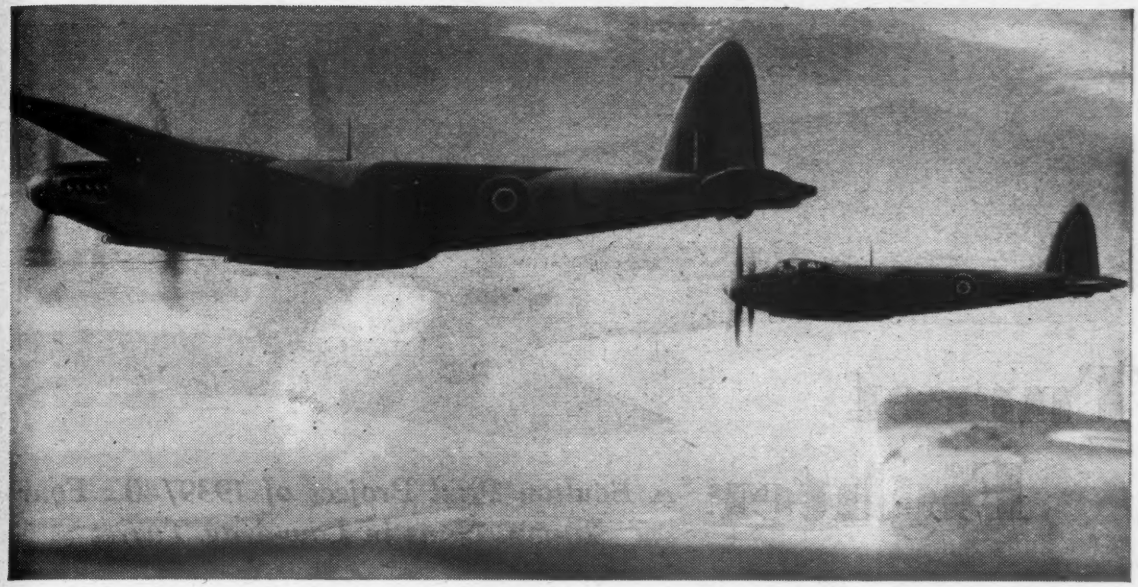
Irvin-type canopies and harness formed the basis of all parachutes used by Airborne Forces and saboteurs, and Irvin technicians collaborated in the development of nearly every other type of parachute used against the enemy.

Genuine R.A.F.-type parachutes, namely Irvin Air Chutes, incorporating all their original features and the actual designers' latest improvements, are now obtainable only from the inventors and patentees.

IRVIN
AIR CHUTES



THE IRVING AIR CHUTE OF GREAT BRITAIN LTD., LETCHWORTH, HERTS, ENGLAND
Telephone No LETCHWORTH 888 Telegraphic Address : IRVIN, LETCHWORTH



WOODEN WALLS: Their Sea Mosquitos in impeccable formation, No. 811 Squadron takes up its station for the great Victory review. Some of the most modern fighters and multi-purpose aircraft, including the Blackburn Firebrand, bear Naval markings.

Victory Fly-past

Full Programme Carried Out Despite Bad Visibility

ENGLISH weather, the weather that spoils most of our pleasures and helps us only in adversity, did its best to stop the R.A.F. fly-past but failed miserably. That, in a nutshell, is the story of June 8th.

I had been invited to fly in the parade in a Mosquito of No. 4 Squadron, which had come over from Germany with the rest of No. 140 Wing (Nos. 21 and 107 Squadrons).

At Manston airfield, from where the Wing started, the morning was hot and fine, even the "Met." briefing only led us to expect a bit of low cloud at 500ft, and haze.

And it was in this weather that we got into the Mosquitos at 11.30 a.m. in our shirt-sleeves.

The Wing had been practising for this show for the past two months, and it was obvious as the aircraft taxied out to the take-off point at the end of the vast Manston runway that the chaps knew the drill perfectly.

During the preliminary sweep over East Anglia to join the main stream on its straight run to London the weather deteriorated rapidly. As we ran into one bad patch the Wing formation leader, Wing Cdr. Corkery, had to make a hasty departure with engine trouble. After a disturbing moment or two the formation settled down again under its deputy leader Sqn. Ldr. Golightly, D.S.O., D.F.C., and the spare man filled the gap.

Sodium lights and smoke flares on Fairlop airfield were just discernible, to help the stream to keep an exact course.

The weather by now was extremely bad. Quite frequently the aircraft immediately ahead—spaced only one machine's length away—would be out of sight. The roads had an appearance of being deserted until it was realized that all the traffic had stopped to watch the formations.

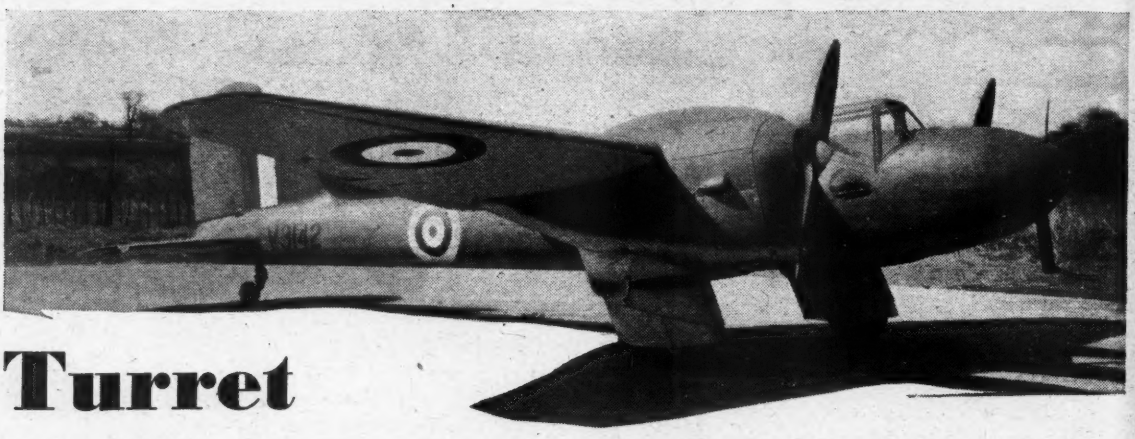
We were over the saluting base at 1,000ft exactly on time, and, as we passed over, the formation leader called out our code words to the ground control, Mint Sauce—Iceberg No. 4 Squadron. Singularly appropriate it seemed. The weather was anything but summery and No. 4 Squadron sport blue noses to their Mosquitos.

When the Hurricane came into view only a few shelterers forsook the dripping trees in Hyde Park where *Flight's* ground observer waited. The familiar silhouette passed unhurriedly beneath the low cloud and disappeared over Kensington, the Merlin's note merging with the boom of approaching Sunderlands. With this the crowd began to seep out into the paths and open spaces to follow the majestic passage of the three big boats, their hulls livid against the grey sky, and when the broad-spanned Halifax transports crossed Park Lane all but the weariest and wettest faces were upturned. Thus the formation of light-painted Lancasters came in for its full share of admiration and the succeeding squadrons of Mosquitos were constantly under review.

Gradually the multi-Merlin roar gave way to the quieter whistling note of Beaufighters whose low sweep was followed until attention was claimed by the Firebrands.

The note of the engines changed again and the squadron of Fireflies, as strange to Londoners as the Firebrands, crossed Marble Arch, followed on differing courses by unit after unit of Seafires and Spitfires with wings of varying silhouette, some clipped, but others reminiscent of the glorious Mark I. The rushing roar of their Griffons and Merlins clashed with the proud music of regimental bands returning to the Park after their march, but recognition of the martial tunes became difficult as a concentrated roar developed along Piccadilly. A few seconds and nine Hornets came over fast and low, their jutting nacelles and squared tips perfectly aligned. The subdued whistling of Centaurus-engined Tempest IIs eventually superseded the crescendo of massed Merlins, giving way in turn to Sabres in Tempest Vs.

There was something symbolic about the swift, graceful passing of the Hornets and Tempests withdrawing before the first Meteor squadrons. So far only three of the scheduled squadrons had not been visually accounted for but as the last of the Meteors thundered away over West London no more aircraft came into view and it was evident that the Vampire unit had passed unobserved.



Turret Fighter

A Boulton Paul Project of 1939/40 : Four 20-mm Guns in Low-drag Turret

IN the design of powered gun turrets and in their application to aircraft Britain admits no equal. To a large extent our reputation in this respect is due to the pioneer Boulton Paul 4-Browning turret developed initially for the Defiant and adapted for more widespread application when the turret fighter was found to be superfluous to our wartime requirements. In the early days of the war the possibilities of this class of fighter appeared to be such that Boulton Paul designed round a low-drag turret with four 20-mm guns a 19,000lb fighter with two Rolls-Royce Vulture engines.

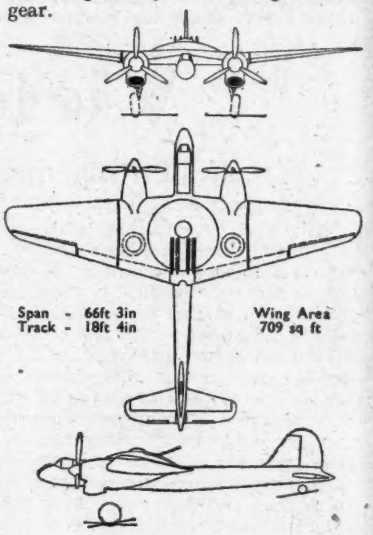
GENERAL PARTICULARS.
Two Rolls-Royce Vulture II engines driving D.H. Hydromatic airscrews.

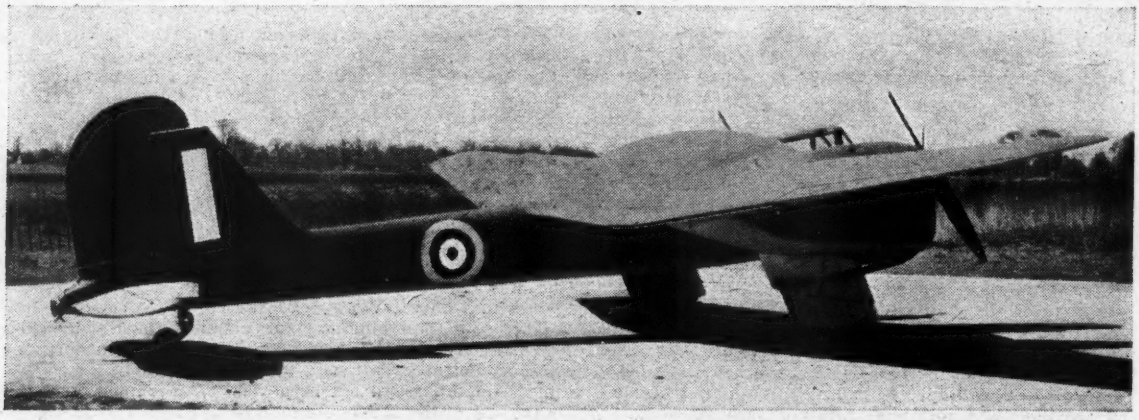
Normal fuel capacity	328 gal.
All-up weight	19,100lb.
Maximum speed at sea level	299 m.p.h.
,, ,, 15,000ft	371 m.p.h.
,, ,, 30,000ft	352 m.p.h.
Maximum rate of climb at 15,000ft ...	2,900ft./min.
Service ceiling	37,000ft.
Take-off run	280 yds.
Distance to touch down over 50ft screen	200 yds.

The outstanding feature of the design was that the cupola of the turret merged into the high wing, and the guns were almost completely within the body of the turret.

The P.92, as the projected fighter was designated, was to seat a crew of three—pilot, navigator and gunner—and was to have a range with auxiliary tankage of 2,000 miles. A half-scale model with two Gipsy engines was built and flown extensively, but soon after work on the full-scale prototype was started it was decided to transfer all design activities to turrets.

It will be gathered from the accompanying G.A. drawing that the design of the turret permitted a fuselage of exceptionally small cross section. Technical data are given in the accompanying table. It will be seen that the estimated performance is outstandingly good for an aircraft designed six years ago and would doubtless have benefited from the installation of engines with a lower frontal area and a higher degree of supercharge than the Rolls-Royce Vultures which gave 1,710 h.p. at 15,000ft in high blower gear.





The ingenious design of the low-drag turret which merged with the high wing of the Boulton Paul P.92 permitted a fuselage of exceptionally small cross-section ; this will be observed in the above views of the half-scale flying model.

Easier Flying

The Need for "Operational Simplicity" in Private-owner Types : A Designer's Views

AT regular intervals there appears the very vexed question of aircraft control—and the need for its simplification if private aircraft are ever to become really popular. In this issue "Indicator" expresses a number of views on the means by which such simplification might be practically applied and on the possible dangers involved in the over-simplification of flying training.

It will be interesting, therefore, to quote a few of the ideas of an American aircraft engineer* who has had a great deal to do with the development of simplified aircraft types in the smaller classes. No attempt has been made to follow all the technical reasoning involved in the suggested design, though the salient arguments are covered.

In his opinion the safe operation of "personal aircraft" will be possible not so much by simplifying the aircraft itself as by rationalizing the methods of control operation and reaction. Just as the driving of a car has been simplified by the addition of complex mechanisms, so the aircraft engineer must be prepared to deal with the problem in terms, if necessary, of mechanical complication so as to provide, for the pilot, operational simplification.

The primary hazards in flying are the necessity for skill and judgment and the present frequency with which the failure to show such skill and judgment is catastrophic. The principal difficulty lies in the "six degrees of freedom" obtainable in an aircraft. These freedoms may be described as vertical, lateral and longitudinal "translation" and rotation about the vertical, transverse and longitudinal axes. In short, an aircraft may move in a direction other than that which it points, and this is particularly noticeable while making an approach and landing. Apart from the more general problems introduced by the "six freedoms," the position is further complicated by the control system at present used, in which four controls deal with the six motions, while only two of these controls can be used independently; a good deal of trained co-ordination is therefore necessary.

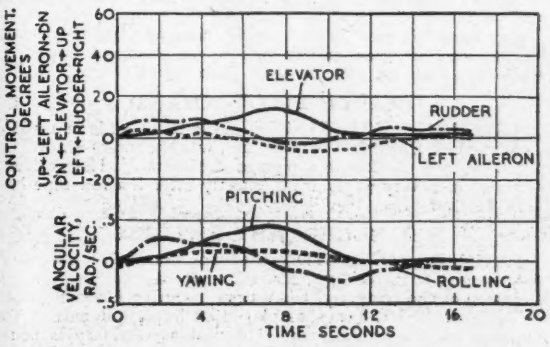
In addition to these more obvious difficulties, the amateur pilot may also be faced with unexpectedly bad weather, and it is, therefore, essential that the range of his view should be improved and that the aircraft should be controllable at a minimum flying speed.

The accident figures in America for the years 1941, 1942 and 1943, are interesting. In these years, 50.8 per cent were caused by "control problems"—stalls, spins, landings, take-offs and taxying—and 25 per cent by collision in flight either with the ground or, occasionally, other aircraft; only the remaining 24.2 were concerned with other hazards.

"Freedom" Restriction

The solution of this primary control problem involves a reduction in the complexity of the movements by eliminating unnecessary combinations. Perhaps the simplest conception is that of aircraft which always moves in the direction in which it is pointed, both vertically and laterally—thus reducing the "freedoms" to three—of turning, change in elevation, and change in speed. Though satisfactory in the air, an aircraft involving such a solution would be difficult during landing and take-off. It must, therefore, be designed so that it is substantially level, longitudinally, at all times, and does not need to be "held off" on landing, and which is, at the same time, sufficiently strong and stable on the ground to take a maximum degree of drift.

Best-known of the two-control designs, the Weick Ercoupe has been considerably cleaned up for post-war production. This aircraft is two-control by virtue of interconnection rather than simplification. Mr. Weick's experiences with the development of the type were given in *Flight* of February 1st and 8th, 1945.



These graphs, which show the relative movement and angular velocities of a conventional aircraft's controls during a normal turn, will explain why so much trained co-ordination is necessary for a pilot and why control rationalisation is of primary interest in any discussion of simplified flying.

In general form the ideal specification for a private-owner aircraft, which will satisfy all possible safety conditions, might be outlined under the following headings:—

Tricycle landing gear.
Steerable front wheel operated by aileron control; brakes on rear wheels operated by a single pedal; large rolling radius on front wheel; zero aerodynamic directional stability around rear wheels; and sufficient shock-absorption to permit a landing without hold-off.

Stallproof.
Restricted elevator control: small centre-of-gravity travel (necessary so that the elevator control restriction will be sufficient for all c.g. positions); high longitudinal stability; high damping in pitch; and low moment of inertia in pitch.

Spinproof.
No independent control in yaw (i.e., two-control); low moments of inertia around all axes; principal axis of inertia in roll to be at a substantial negative angle to wing-zero lift; heavy damping in yaw; not too great directional stability; completely satisfactory lateral control at the stall (which should be symmetrical); ailerons should have minimum change in section drag with deflec-

** From a paper read before the S.A.E. National Aeronautics Meeting, New York, by J. M. Gwinn, Jr., of the Consolidated Vultee Aircraft Corporation.*

EASIER FLYING

tion; and airscrew located so that there are no unsymmetrical fin areas within the slipstream.

Low-speed characteristics.

50 m.p.h. minimum flying speed with complete control and good engine cooling; same minimum speed for power on and off; and climb available with full throttle at minimum speed.

Flaps

Automatic flap, down at low speeds and up at high speeds; aircraft substantially level at all speeds; and flap raised automatically when the brakes are used.

View

Unobstructed vision forward and down; the engine should not be in front, particularly as this location is not compatible with low moments of inertia in pitch and yaw.

General safety features.

Non-icing induction system (fuel injection); fuel system requiring no shut-off cock; and control system arranged so that motion of one control does not inadvertently produce motion of another; this suggests the use of foot accelerator for emergency application of power, and with hand throttle for cruising.

With such a layout the conditioned reflexes of a car driver would be used to the maximum possible extent. On the ground the aircraft would be controlled in exactly the same way, and the effect of the neutral aerodynamic stability around the rear wheels would mean that in cross winds there would be no particular yawing forces on the ground. During take-off the aircraft would gain speed while a familiar technique was being used, and, since the flaps would be automatically down, excessive elevator would not be necessary to obtain a correct angle of attack for take-off. The more experienced pilot might use the brake pedal to hold the automatic flap in the "up" position while taking off in strong winds. The climb characteristics would not differ from those of a conventional aircraft except that the nose would not be appreciably higher than in level flight.

Before any control simplification can be considered, the phenomena involved in making a turn should be understood. Briefly, a turn is produced by a horizontal component of lift as a result of banking. The rudder is used solely to prevent undesirable yaw—largely in the interests of a "tradition of precision" which has been present in flying training since the very early days. The primary cause of yaw is that of aileron drag, and the simplest solution of the two-control problem would be to provide ailerons which produce no such yawing tendency. Interconnection of the rudder and ailerons is made more difficult by the fact that they are used at different times during a turn, and not in any fixed ratio. There is, of course, another source of yaw moment—the movement of the nose resulting from inward slip when the aircraft is too directionally stable.

Apart from the use of a tricycle undercarriage with its dynamic directional stability, it is necessary for an aircraft to be stable in cross-wind landings that it should not be too aerodynamically stable around the rear wheels. During a cross-wind landing the dynamic and aerodynamic forces are opposed; in the first place it will be attempting to turn into wind, and in the second the tricycle gear will try to make the aircraft follow the direction of drift. The design should permit the two to cancel out.

Since nearly all serious accidents are caused by contact with the ground in a nose-down attitude, another point in the design would be that of keeping the fore-and-aft attitude constant and towards the nose-up position. This can be arranged by the use of an automatic flap which, though a compromise, could be made to achieve the result. The age-old technique of the engine-off spot-landing would obviously find no place in the operation of a simplified aircraft. The throttle would normally be used to control the glide path unless and until the pilot concerned had developed a sufficient degree of natural skill.

The entire philosophy of private aircraft design should be that of fitting the aircraft to people as they are, rather than of trying to mould people to fit the aircraft.

ROLLS-ROYCE JETS FOR FRANCE

FOLLOWING the recent announcement by the Government, it may now be revealed that Rolls-Royce have granted a licence to Hispano-Suiza to build Rolls-Royce jet propulsion engines in France. French engineers are working in the Rolls-Royce factory at Derby, and Derwent and Nene engines will be supplied to France in addition to drawings and designs. The Derwent engine holds the world's speed record and the Nene is the most powerful aero engine in production in the world.

R.A.F. AND R.N. FLYING CLUBS

AT the Annual General Meeting of the R.A.F. Flying Club held at Bush House on May 30th last, the temporary wartime committee was re-elected and is composed as follows:—Wing Cdr. R. E. G. Brittain (Chairman), Wing Cdr. W. A Hammerton (Vice-Chairman), C. Keith Robinson, Esq. (Vice-Chairman), Wing Cdr. C. A. Pike, A.F.C. (Hon. Secretary), Sqn. Ldr. K. W. Hole (Hon. Treasurer), Capt. A. G. Lamplugh, Wing Cdr. R. S. Sikes, A.F.C., Wing Cdr. E. Shipley, Wing Cdr. R. W. Hase, Wing Cdr. J. H. Brown, Sqn. Ldr. D. MacBeath.

It was confirmed that bar and like facilities of the London Flying Club (also operating from Panshanger Field) were available to members and guests, and that the Officers' Mess of the D.H.-administered E.F.T.S. would cater for members at all meal times and for ladies at prescribed times.

Difficulties with regard to aircraft were mentioned and the position is now given as two Moth Minors serviceable, one serviceable Auster on loan, two Austers on order, and a tender for two Hornet Moths unsuccessful.

The Royal Naval Flying Club is anxious to amalgamate with the R.A.F. Club and membership has been offered to Naval pilots who have the requisite number of flying hours. Increased insurance rates, and therefore increased flying rates, would be necessary if Naval pilots with less than the minimum of 50 hours as pilot are accepted. The present R.A.F. club membership is 237 and the rates are £2 per hour flying time and 2s per hour parking time when landing away by special arrangement at week-ends.

NOT SO HAPPY

TO be considered, perhaps, as a successor to *Tee Emm*, a new journal, mainly for internal preservation in the R.A.F., is being published by the Directorate of Accident Prevention. Its title, *Happy Landings*, might, judging at least from the contents of the March issue, be described as entertainingly cynical; this issue is crammed full of nasty accidents and accompanying blood-curdling titles. Since the journal is intended to discourage dangerous or stupid flying, such is no doubt the way in which to tackle the matter, and the articles should give pilots furiously to think.

Most surprising are the "potted" accident statistics for take-off and landing swings. The percentages given, however, may not offer a particularly true picture, since they are worked out on a basis of hours flown rather than on the number of landings or take-offs made. The Spitfire, strangely enough, heads the list on landings, with 2.8 accidents per 10,000 hours' flying; for take-offs the winner is the Stirling, with a figure of 3·3

Magnificent is the "box" which encourages the readers to look forward to "next month's issue . . . which contains . . . a special article on 'Flying Into High Ground' . . ."

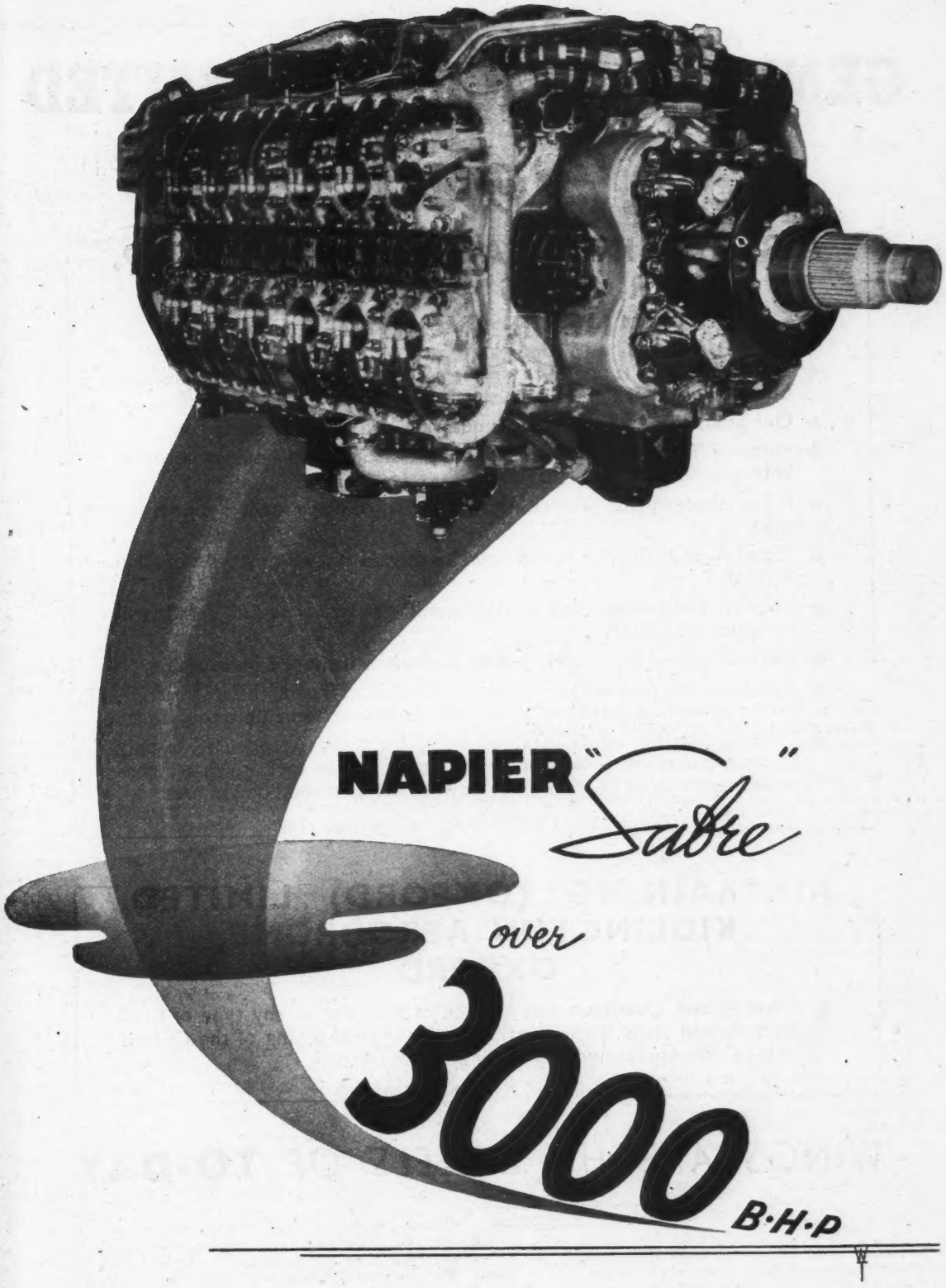
GLIDER PILOT KILLED

MR. GERALD OKE MANNING, who lost his life in a glider crash at Dunstable on June 2nd, was the son of Mr. W. O. Manning, one of Britain's pioneer designers. The accident occurred in a very gusty wind, shortly after the tow-rope had been cast off.

H.P. SECRETARY RETIRES

HANDLEY PAGE, LTD., announce that after 28 years' service with the firm, Mr. Edmund Easy, a director and secretary of the company, has retired. During his long period at Cricklewood Mr. Easy has played an important part in the financial success of the firm. His post as secretary is being taken over by Mr. Ernest Walmsley, hitherto secretary of Aero Engines, Ltd., of Bristol.

The directors of Handley Page, Ltd., presented Mr. Easy with a silver rose bowl engraved with signatures of members of the H.P. staff.



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★ C's of A. and Overhauls can now be carried out to any type of Civil Aircraft.

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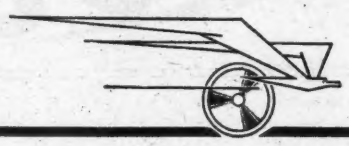
★ C's of A. and Overhauls can now be carried out to any type of Civil Aircraft, and plans are well advanced for the reopening of the Oxford Flying Club, operating from Kidlington Aerodrome.

Telephone: KIDLINGTON 200

WINGS ARE THE WHEELS OF ***TO-DAY***



"Indicator" Discusses Topics of the Day

Not So Simple

Can Aircraft Control be Safely "Rationalized"? : Approaches More Difficult than Landings : Two Extremes : Pre-arranged Co-ordination

AT least in the bad old days it was the habit of one generation to accuse the next of finding things altogether too easy. Because of simple jealousy or of ordinary conservatism, the "old generation" always tended to think that the only real way of learning anything was the hard way. So far as flying training is concerned the same tendency still survives. Pilots of the first "World War" used, in the 'twenties and 'thirties, to be very critical of the care with which pupils were handled, and now we, the products of the between-war training period, are inclined to be equally critical of any modern ideas in training simplification.

Whether or not I am just another subject for psychiatric treatment, I must say that I am one of those who believe that flying *can* only be properly taught in the hard way, and that no pupil brought up in some two-control, stall-proof tricycle affair is ever likely to be really safe. For some years those concerned at the Air Ministry appear to have had the idea at the back of their heads that a training type can be produced which will make the best of both worlds and in which pupils can be started in the way in which they will eventually go. I know, too, that there is a school of training experts who believe that, if air experience and general aircraft handling can be more easily taught by way of a start, the overall training time will be shortened. But I am not convinced. The idea of anybody learning to fly in something which has not got most of the basic characteristics of a really old-fashioned flying machine is nothing if not disturbing.

Nobody who remembers the awful possibilities involved in handling advanced types will find it easy to believe that there is any good short cut to full flying experience. Surely it is better to learn the worst in something subject to all normal vices, yet controllable to the limit; and in something which must be landed properly, yet which is not actually lethal when mishanded near the ground. The ideal basic trainer should be an aircraft which will develop wild aerodynamic bounces if it is put down before flying speed has been lost; which will spin sharply but controllably if so permitted; which is sufficiently lightly loaded to be *felt* all the time: and which stalls at a speed low enough for even a small amount of drift to be noticeable. Once the pupil has got past the instructor on such a type, he or she should then be safe on anything.

Basic Experience

Certainly, I am sure that very few of the original A.T.A. pilots would have survived, when poured into advanced military types after a minimum of "conversion" dual, if they had not already been properly taught in the old-fashioned type of aircraft. Those who learnt to fly in the early club days had to deal with easy-going, but, nevertheless, easily broken aircraft with high-pressure tyres and narrow undercarriages, with inadequate power reserves, and with sensibly marked auto-rotation tendencies if mishandled.

The need to put such aircraft down not only at the ultimate stall but also squarely in relation to any wind which might be blowing, seems to me to be of vital importance in any later flying, and the careless ease with which many low-wing types can be landed provides the pupil with no really adequate experience. If the low-wing type also has a tricycle undercarriage, then one has neither to land it properly nor into the wind. As far as I can remember, I used up quite three instructional hours, after the moment when I might otherwise have gone solo, in learning to correct drift which I was myself inadvertently "building in" at the moment of hold-off. The experience obtained during those three hours has not been forgotten, even though I complained bitterly about it at the time. Reflexes which are learnt in an aircraft sensitive to the slightest amount of drift, either artificially produced or otherwise, can never be forgotten.

While on the subject of cross-wind landings, it always seemed to me that rather too little was made of these in Service training during the war. And that was through no fault of the A.F.U. or O.T.U. instructors, who would have been only too keen to give pupils all the experience possible had they not been encouraged into somewhat milk-and-water methods by the higher-ups. So much fuss had been made of a comparatively high instructional accident rate that it was almost more than their careers were worth to take any chances at all with the pupils.

Unnecessary Accidents

We had, therefore, the absurd situation in which many good, new fighting aircraft were accidentally destroyed in Burma and elsewhere in order that a few non-operational and largely worn-out fighters could be saved from similar destruction in this country. From what one heard, very few of the chaps who were expected to go to war on and off one-way wire-mesh strips (which were usually out of wind) had had much real experience of cross-wind take-offs and landings with the type of aircraft used. Whereas, in war conditions, a perfectly good fighter, more or less straight from the packing-case, could be written off in a ground loop without causing any grave personal anxiety, a similar occurrence in training, involving an out-of-date fighter, was liable to produce the most unpleasant repercussions. The accident statistics given in the March issue of *Happy Landings* are illuminating. The Spitfire heads the list for "swings on landing," yet if ever there was a fully controllable affair, the Spitfire was one, in spite of its narrow undercarriage. Except in extreme conditions, the only excuse for breaking this type during a cross-wind arrival would be inexperience in the essentials of drift correction—which should have been taught in the very early stages of training.

Returning to my original line of thought, there seems to be one outstanding and quite logical reason why no flying machine can ever be made as simple in its control as, say, a road vehicle. Whatever an ingenious designer may choose to do with an aircraft in order to simplify its characteristics and make it more "driveable" in the hands of the absolute novice, an aircraft must still move—and, therefore, be controlled in three axes. Whereas a car needs only to be controlled directionally, an aircraft is able to vary its fore and aft as well as its lateral attitude. All this is really too simple to be worth mentioning, but the fact remains that thousands of non-flying people still persist in thinking of flying in terms of future one-control simplicity. There are actually six "freedoms" in aircraft movement.

A very great deal of fuss has always been made of the difficulty of landing an aircraft, and simplification efforts have been directed largely towards means by which this process can be made easier for the ordinary person. Of course, it *is* difficult to learn to balance it, to keep it straight, and, at the same time, to judge height and speed with accuracy, while the work is being done with the aid

of controls which, to the ordinary person, can be somewhat unnatural.

But this much-stressed landing difficulty is far less prominent a source of error than that of judging a final approach. Whereas a pilot who has put in a few hundred hours on different types can more or less guarantee a fair, if not actually a good landing on anything, the same pilot, even after a couple of thousand hours, is still never quite sure of himself during the approach. He has learnt, by a complicated process of visual judgment and trial and error, to know whether he is tending to undershoot or overshoot at any particular point during the approach, but he never learns enough not to find himself in one or other of these positions. There are, obviously, so many variables present during the process that perfection can only be temporarily attained when exactly the same aircraft is being flown in entirely similar conditions hour by hour.

NOT SO SIMPLE (CONT.)

Even when, with the help of a tricycle undercarriage, limited elevator control, and a system of control-linkage, the aircraft has been arranged so that an entirely inexperienced driver should find no difficulty, under ideal conditions, in parking it unbroken, this same driver can still run into the most outstanding trouble while making an approach. It will require at least as much practice time to learn to deal with these troubles, through steadily improved judgment, as it would to learn to land some difficult and old-fashioned contrivance with three separate controls and somewhat tricky characteristics.

And the person who has learnt to fly in the box-kite will be in a very much better position, at any hourage figure, when bringing an aircraft in across wind or on to a runway. Even if the pilot has been taught to apply instinctively the requisite amount of skid to counteract the drift, it may not be possible to hold any simplified "the-air-for-all" device in the appropriate attitude. Even the best tricycle undercarriage cannot accept an unreasonable amount of drift. Yet one-way strip-landing conditions, in which the greatest trouble is likely to be experienced, are just those which the ordinary private-owner is most likely to meet. A machine which can only be safely landed into wind on a fair surface is obviously not going to be of very much use for day-to-day travels in all conditions and in the hands of absolute amateurs.

In most simplified control arrangements the modification has involved either the removal of the rudder control, or its combination with some other. Perhaps this has been because the rudder, operated in conventional aircraft by the feet, is the most difficult of all to master, or, maybe, because this control, in present-day designs, needs to be used for little more than yaw-correction.

Ancient and Modern

I found it interesting, therefore, a few weeks ago, when I had the opportunity of flying two types which were just about as dissimilar as they could possibly be. The first was a light aircraft of the old type, while the second was one of the "new" kind, in which control simplification had gone as far, in my opinion, as is reasonably possible with present airframe layouts.

The first—none other than our old friend the Westland Widgeon, and possibly the only one of its type still flying—is a parasol monoplane with the kind of characteristics which were accepted without question in the 'twenties and 'thirties. While aileron and elevator control reactions were more or less normal by present-day standards, the rudder effects were of a calibre not to be met in many modern types. In spite of the fact that the Widgeon has no appreciable fin area, the aircraft is directionally stable and it is possible to hold it indefinitely in a side-slip or skid of the 30-degree-off-straight calibre. In fact, to watch Mr. Penrose, the Westland chief test pilot, doing his worst with this old war-horse took one back to the golden age of aircraft.

With this kind of machine the rudder is, in fact, the master control. Its use in instituting turns or in correcting aileron yaw is quite subsidiary to that, when helped by fuselage keel-surface, in losing height and/or speed at will. In the days when the Widgeon originally appeared, the motoring approach was unknown, flaps had still not been seriously invented, and arrivals were deliberately arranged so that there was always a couple of hundred feet still to be lost over the boundary. By the use of very coarse top rudder, this height could be lost quite instinctively, but in a performance which, to-day, would look suspiciously like dangerous flying. In those times people were forced, by the very nature of the aircraft, to make the maximum and accurate use of the rudder in combination with the other two controls.

The "modern" aircraft, which I flew a few days later, was the Miles M.48—which is virtually a "one off" experimental version of the M.38 Messenger. In this the rudder, though adequate for normal purposes, can fairly be described as being for incidental use only. In all ordinary circumstances the pedals can be ignored.

Rational Controls

Perhaps this reduction in the status of the rudder is what is needed in the way of rational simplification; the control is available for essential purposes, but is not all-powerful and need not be moved with any accuracy. Obviously, other means of varying the engine-off approach angle must be provided, and the use of variable degrees of lift flap and (in the case of the M.38) of plain drag flap provides the necessary control. For a conventional layout, a type like the M.38 has probably reached something very near the limit, too, in stall-proof possibilities.

If further simplification is really required, it would seem that a useful line of attack might be that of control rationalization in the cockpit rather than of any modification of the surfaces. Since we already have aircraft which are virtually "two-control" in their handling, but which still have a rudder available, it might be possible to organize the system so that the movements are more natural.

Before the war something of this kind was tried in the Hordern-Richmond, a light twin-engined type in which all three surfaces were moved by a single control. A column, which moved in the usual way to operate the elevators and ailerons, was surmounted by a wheel controlling the rudder. In the Chrislea Ace prototype the designer has done much the same thing, but, in this case, he has given the wheel the possibly more natural function of aileron control. Rudder movements are made by a pivoted side-to-side action of the horizontally mounted stub column, while the elevators are controlled by an up-and-down movement around the same fulcrum point.

Certainly, a pilot brought up on a conventional aircraft could not cope immediately with the Hordern-Richmond, and it remains to be seen whether the reversal of the rudder-aileron functions of the wheel, coupled with the special movement of the "column," will make the entire action more natural both for the trained pilot and the newcomer. Even if the Chrislea arrangement does not, after all, prove to be satisfactory from the pilot's point of view, it seems that there might still be a good deal in the idea of devising some all-in-one system which is so natural in action that one's untrained reflexes are the immediate and automatic translation of one's wishes.

FORTHCOMING EVENTS

June 15th.—Old Cranwellian Assoc. reunion, R.A.F. College.

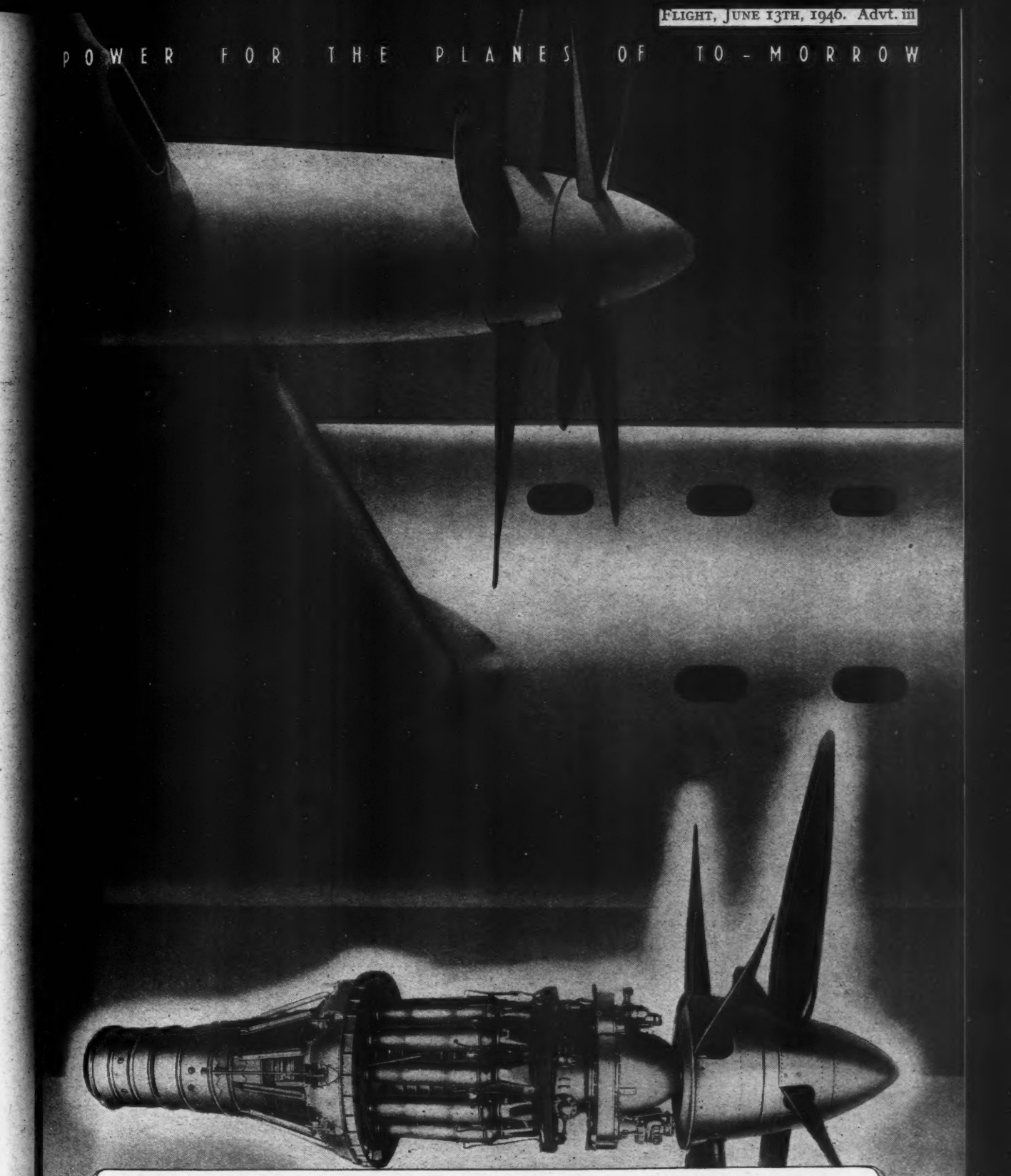
June 15th.—No. 150 Sqn. R.A.F. reunion dinner, Dorchester Hotel, 6.30 p.m.

June 17th.—The Royal Society's Empire Scientific Conference opened by the King in London University 11 a.m.

June 18th.—Aero Golfing Society (*Flight* Trophy), Weybridge.

June 19th.—Sir Frederick Handley Page at Gauge and Tool Makers' Assoc. luncheon, Savoy, 12.30 p.m.

POWER FOR THE PLANES OF TO-MORROW



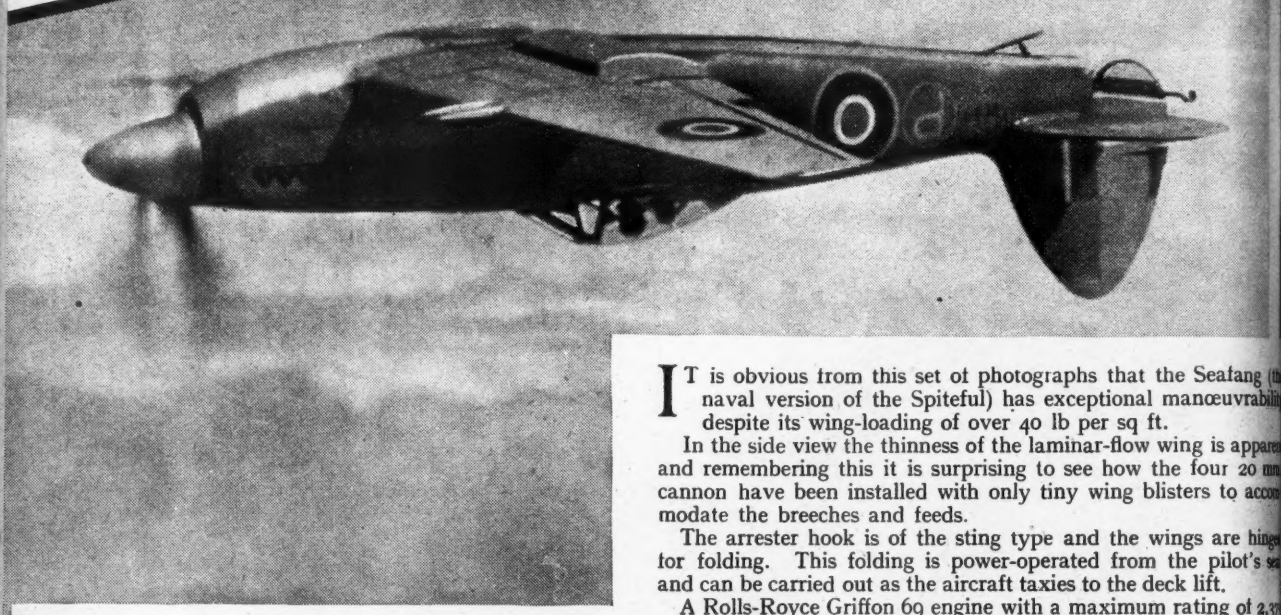
ARMSTRONG SIDDELEY

PYTHON

One of the most powerful aero engines in the world

SUPERMARINE SEAFANG

Jeffrey Quill Demonstrates the Navy's Latest Fighter



IT is obvious from this set of photographs that the Seafang (th naval version of the Spiteful) has exceptional manœuvrabilit despite its wing-loading of over 40 lb per sq ft.

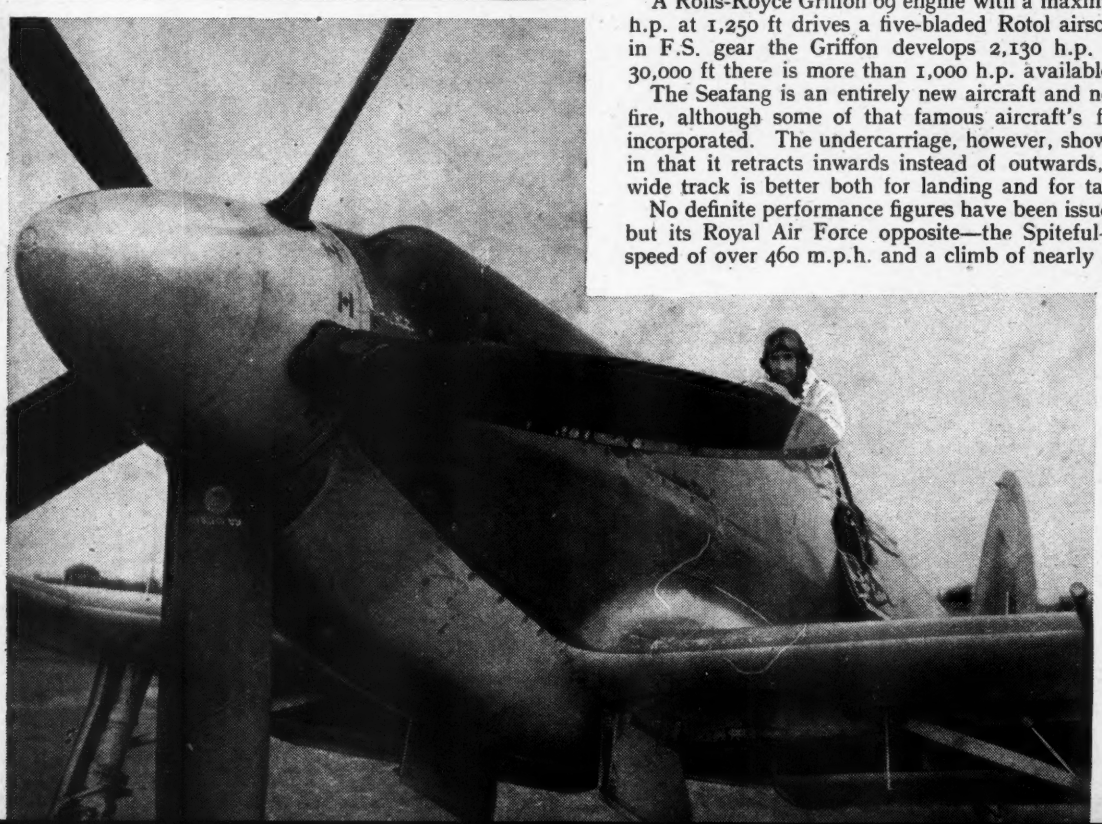
In the side view the thinness of the laminar-flow wing is appare and remembering this it is surprising to see how the four 20 mm cannon have been installed with only tiny wing blisters to accom modate the breeches and feeds.

The arrester hook is of the sting type and the wings are hinge for folding. This folding is power-operated from the pilot's se and can be carried out as the aircraft taxies to the deck lift.

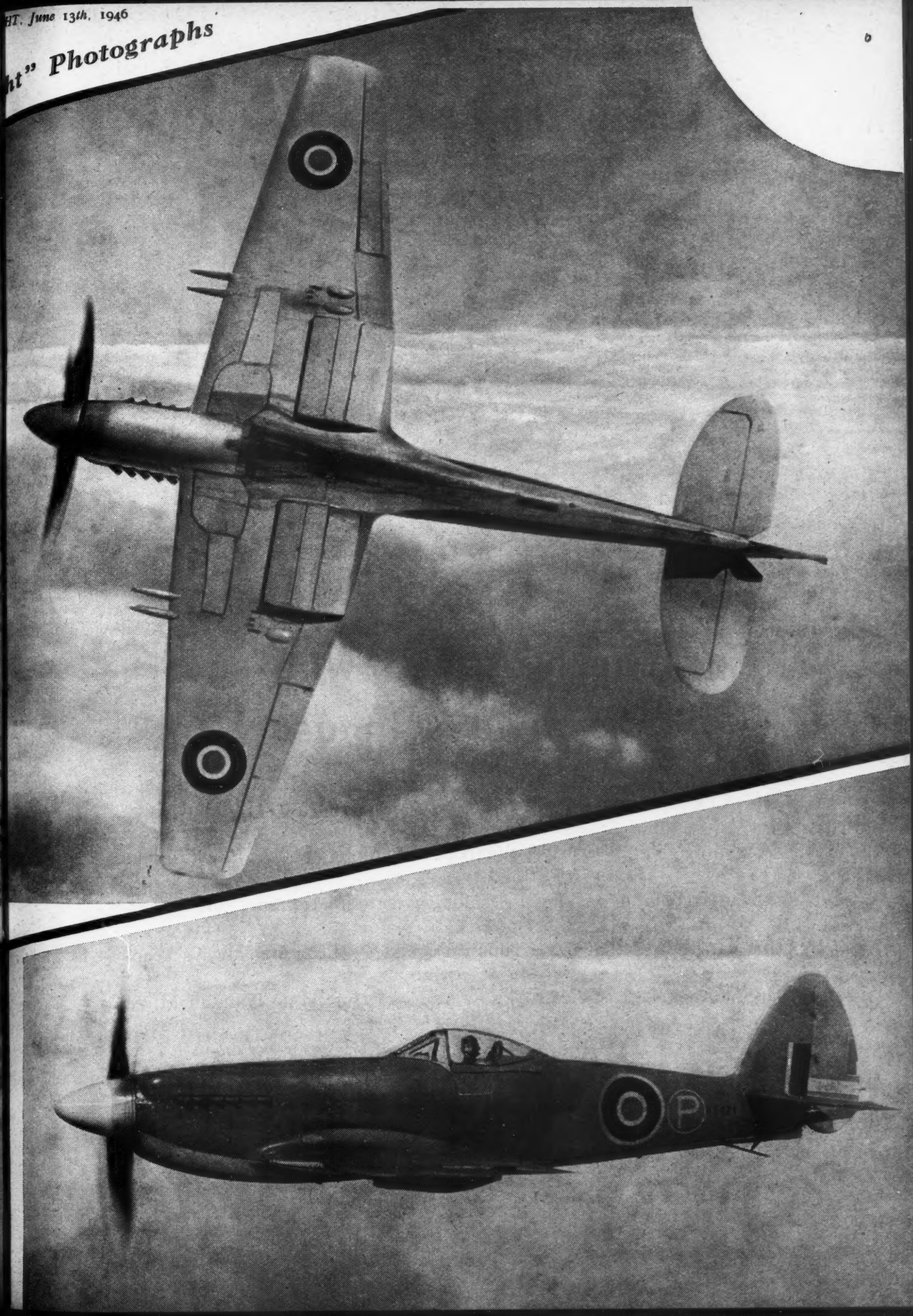
A Rolls-Royce Griffon 69 engine with a maximum rating of 2,3 h.p. at 1,250 ft drives a five-bladed Rotol airscrew. At 15,500 f in F.S. gear the Griffon develops 2,130 h.p. and even at ove 30,000 ft there is more than 1,000 h.p. available.

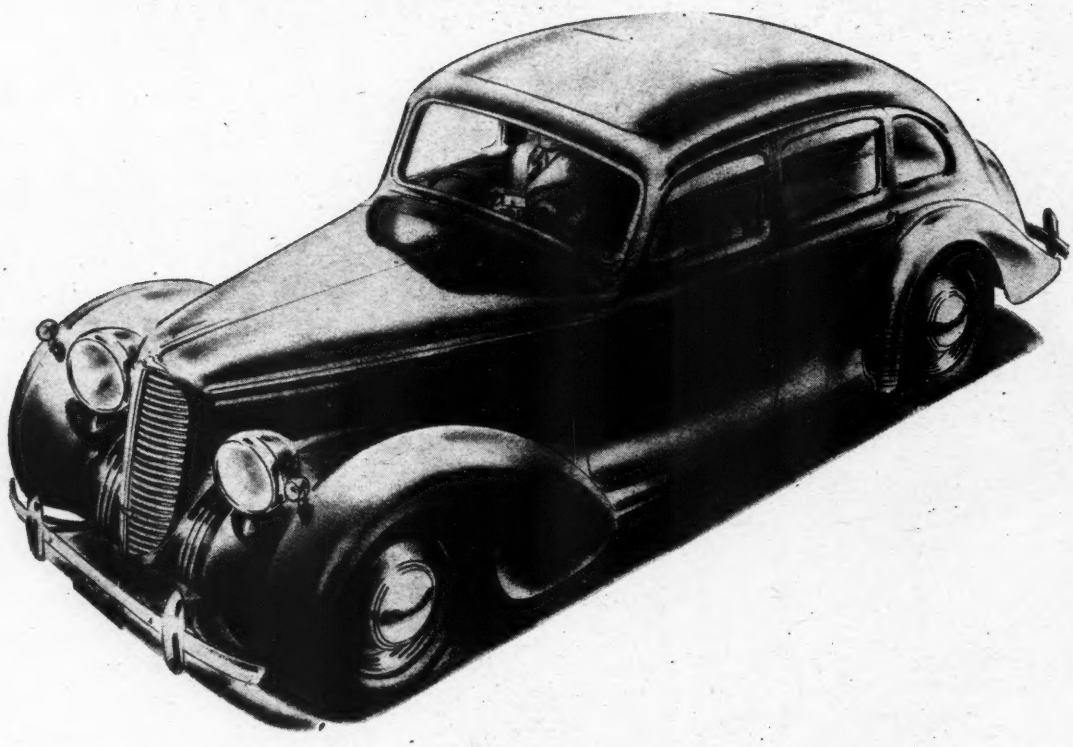
The Seafang is an entirely new aircraft and not a modified Spi fire, although some of that famous aircraft's features have bee incorporated. The undercarriage, however, shows a radical chang in that it retracts inwards instead of outwards, and the resultan wide track is better both for landing and for taxying.

No definite performance figures have been issued for the Seafang but its Royal Air Force opposite—the Spiteful—has a maximum speed of over 460 m.p.h. and a climb of nearly 4,000ft per min.



"Flight" Photographs





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How nice to know you needn't worry about your Hillman Minx. A comfortable car to drive, quietly purring along at 50 . . . quick to take advantage of an opening in traffic. A smooth running, safe-cornering car. A car that never runs up costs . . . a car that always keeps appointments. It's nice to know you can trust your Hillman Minx.

HILLMAN MINX

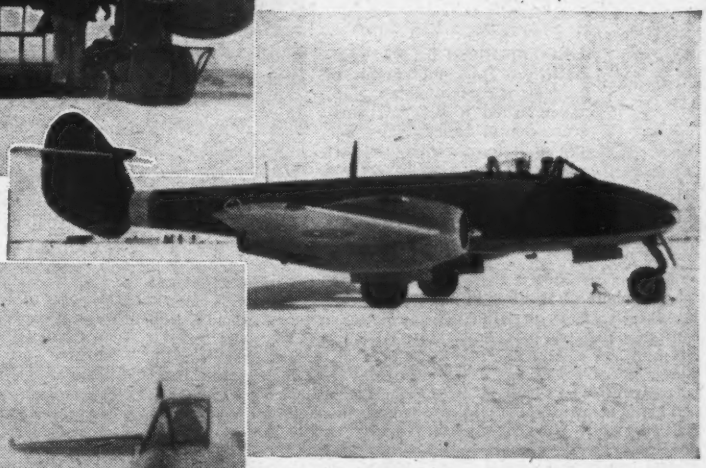
The Hillman Motor Car Co. Ltd., Coventry

A PRODUCT OF THE ROOTES GROUP

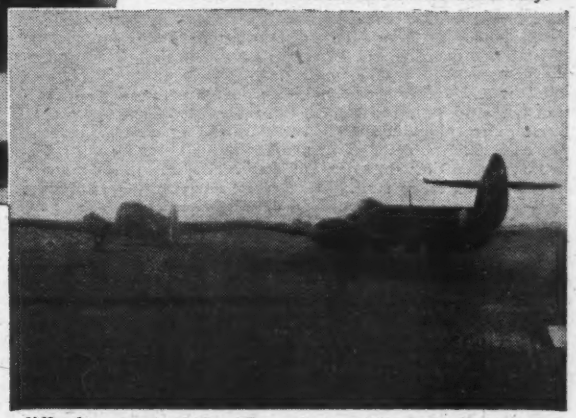
METEOR CLIMATIC TRIALS

Standard Meteor IIIs Proven Suitable for Desert and Arctic Operation : Trouble-free Tests

(Above) Servicing personnel at Edmonton with an R.C.A.F. Meteor III on which the sub-arctic suitability trials were carried out.



(Above) Running-up at the very low ground temperatures obtaining caused no difficulty whatsoever. Note chock for nose-wheel only.



(Above) Assembly of the starboard Derwent in Sudanese summer conditions at Khartoum. (Right) Artificial sand-storm created by running Anson engines ahead of Meteor.

IN order to establish exactly how suitable jet aircraft are for operation in severe extremes of climate, a series of trials were conducted some months ago with standard Gloster Meteor IIIs. It is important to stress the fact that the aircraft were completely standard machines with no special precautionary devices fitted, since the results of the trials show up the Meteor to such advantage in this respect.

The first trials were for tropical conditions and took place at Khartoum. Ground temperatures averaged 25 deg C and, among other investigations, simulated sand-storm conditions were obtained by placing an Anson about 50 yards directly ahead of a Meteor and running-up the Anson's engines. It was naturally expected that some damage to the Derwent gas turbines would be manifest, but in point of fact the effect on the compressors and turbine blading was so slight as to be negligible. The Meteor thus passed the trials successfully and is the first jet-propelled aircraft to be cleared for operation in desert conditions.

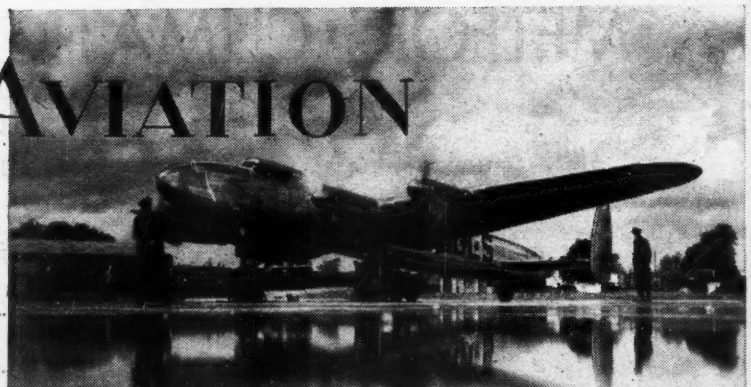
"Winterization" trials were conducted by the R.C.A.F. at Edmonton, Alberta, where ground temperatures averaged −35 deg C. Burning paraffin as they do, some difficulties with the Meteors in starting and fuel supply were naturally expected, but again, curiously enough, no such difficulty eventuated. The only troubles experienced were connected with synthetic rubber sealing glands which, at the very low temperatures obtaining, tended to become brittle and, by losing their ductility, to leak. Hydraulic fluid did not lose its fluidity, and no adverse effects on the operation of hydraulic services were found. The matter of the sealing glands is being rectified, and the Meteor will thus be cleared for sub-arctic operation.

The tropic trials were undertaken in September, 1945, and the winter trials in December, 1945, and January, 1946. Both sets of investigations were carried out by Service personnel on standard Service machines, with technical representatives of Glosters and Rolls-Royce present.

No figures have yet been made available to indicate how the extremes of climate affect the flying performance of the Meteors, but the fact that standard machines can be operated virtually anywhere in the world without recourse to modifications for meeting special climatic conditions would appear to offer great advantages in contrast to the requirements of conventional airscrew-driven aircraft.

CIVIL AVIATION

P.I.C.A.O. and Multilateral Agreements : Selecting a Flying-boat Base



UNCOMFORTABLE REFLECTIONS: This photograph of London Airport on May 28th, taken when a B.O.A.C. Australia-bound Lancastrian made use of it for the first time, is somewhat reminiscent of a few of our wartime airfields.

A WEEK OF P.I.C.A.O.

At least from the British point of view, the most important event of the first week's proceedings of the P.I.C.A.O. Assembly in Montreal was the presentation by the British delegates of a series of "Working Principles for the Framing of a Multilateral Agreement." This First Interim Assembly of P.I.C.A.O. opened on May 21st in Montreal, and was expected to break up before the end of last week.

The "Working Principles" were, in fact, an outline of British policy towards national air transport and a natural development of the Bermuda "philosophy." Sir Donald Banks, the leader of the United Kingdom delegation, spoke in support of the tabled "Principles" and stated that the British Government, in pursuing the orderly development of air services, regarded the establishment of an international organization as the most effective means of attaining this objective. Until, however, there was sufficient international support for such an organization, the British Government favoured a multilateral agreement. This, while providing a universal code of rules, would conserve the greatest degree of freedom for air transport and would safeguard the rights of different States.

After Sir Donald's speech, Mr. Welch Pogue explained the United States' point of view, which was that, though an international operating organization was a fine ideal, it was not only impractical, but also likely to be harmful and stifling to the best interests of aeronautical development.

The presentation of the British "Principles" was made on May 30th, and on the following day the air transport committee discussed the draft Multilateral Convention which the Assembly had agreed not to adopt. This discussion, therefore, was intended to give the Member States a chance to air their detailed views in the matter of modification.

On the first day of the Assembly, the afternoon of which was devoted to the usual speeches of welcome and to opening statements by the various delegation heads, two significant points were made by Mr. C. D. Howe (Canada) and Mr. W. Burden (U.S.). The former declared that he was in favour of immediate progress on the full Multilateral Agreement on Air Transport, a draft of which has been prepared by the Air Transport Committee, while the latter took the opposite view and considered that sufficient experience had not yet been gained to make the adoption of such an agreement possible at the Assembly. Instead, Mr. Burden asked for a "single simple document" to replace the complex document prepared.

On the second day of the assembly (May 22nd) the various officers were elected. The chosen President of the Assembly was Mr. Louis de Brouckere (Belgium), and the five Vice-Presidents were: R. A. C. Henry (Canada), A. S. Drakeford (Australia), Dr. Shih Sun Liu (China), Luis Alvarado (Peru), and Max Hymans (France).

For detail work the Assembly was split into five Commissions covering: (1) General policy; (2) Air Navigation; (3) Air Transport; (4) Legal Questions; and (5) Administration and Finance. The British representatives on these various commissions were: (1) Sir Donald Banks and Sir Frederick Bowhill; (2) Sir Frederick Bowhill, Wing Cdr. G. L. Gandy, Mr. D. Rolinson and Sqn. Ldr. Carter; (3) Mr. L. J. Dunnett and Mr. Peter Masefield; (4) Mr. K. M. Beaumont, General Wilberforce and Mr. Maurice E. Bathurst; and (5) Mr. H. G. Vincent.

CAPITAL ISSUE

THE capital of B.O.A.C. has now been increased to the limit of £10 million provided for in the British Overseas Airways Act of 1939. This announcement was made last week by the Chancellor of the Exchequer, who explained that authority had been given to the Corporation to make a new issue to the National Debt Commissioners, under Treasury Guarantee, of £5¾ million of 2½ per cent Airways Stock 1971-76, at a price of £99 per £100 of stock. The purpose of the issue is to repay temporary advances and to pay for aircraft and other new capital assets which have to be met in the immediate future before the new Civil Aviation Bill can become law.

The previous issue by the Corporation of £4¼ million of 3 per cent Airways Stock 1960-70, was made in March, 1940, the price then was £95 per £100 of stock.

CIRCUIT INTERSECTION

THE fact that Northolt and Heathrow are inside each other's circuits has necessitated the institution of special circuit rules. When the landing direction at Northolt is East or South-east, a left-hand circuit is made, with a right-hand circuit for the other runway direction. At Heathrow a right-hand circuit is made when the landing direction is towards the East on the single runway.

AIRPORT APPOINTMENTS

THE Ministry of Civil Aviation have now made the following appointments of airport managers:

Belfast: Mr. W. H. Kearney. Inverness (with responsibility for Hatston): Mr. A. Hutcheson. Dyce, Aberdeen (with responsibility for Wick): Mr. R. A. Hobday.

CATHODE-RAY D/F

LAST month a part of the R.A.F. long-range cathode-ray D/F organization came under the control of the Ministry of Civil Aviation at six points as far apart as Dyce, St. Eval (Cornwall) and the Azores. The organization provides "fixing" facilities over an area bounded by the parallels 65 deg and 40 deg N and by the meridians 10 deg E and 6 deg W. All the stations operate on a frequency of 6,500 K/cs.

AUSTRALIAN DEVELOPMENT

IMPETUS has been given to the development of civil aviation in Australia by the Federal Government's decision to operate its own air service on trans-oceanic and internal routes in competition with private enterprise. The Government has already invested £11,500,000 in airfields, and in navigational and meteorological aids—more than eight times the amount invested for these purposes by private airlines—and is committed to further expenditure on airfields, including £8,000,000 at Sydney and Melbourne alone. Mascot airfield, Sydney, is to be a trans-ocean terminal.

The increased responsibility thrown on the Department of Civil Aviation, under the Director-Generalship of Air Marshal R. Williams, has resulted in the formation of four new Directorates: Air Transport and External Relations, Air Navigation

and Safety, Airways, Airports. In addition, two main branches of finance and administration have been created.

CROYDON—EINDHOVEN

A DISTINGUISHED civic company assembled for lunch in Croydon on June 4th in order to celebrate the inauguration of the new K.L.M., Royal Dutch Airline's service between London and Eindhoven. The first aircraft on this service had arrived at Croydon on schedule the same morning, bringing with it an official party from the Netherlands, including the Commissioners of H.M. the Queen of the Netherlands, in the provinces of North Brabant and Linburg, the acting Mayor of Eindhoven, the Mayors of Maastricht and Beek, Mr. H. Martin, managing director of K.L.M., and also Mr. F. J. Philips, a director of Philips Works at Eindhoven.

INAUGURAL FLIGHT: A K.L.M. Dakota on arrival at Croydon Airport after making the first flight on the new Eindhoven-London service last week. It still bears its war paint—a reminder that Holland's slow and painful recovery from a grim period in her history still continues.

The aircraft was met at Croydon Airport by the Mayors of Croydon and Woolwich, Mr. Th. H. de Meester, Consul-General for the Netherlands, Capt. H. Spry Leverton, K.L.M.'s Regional Director for the U.K., and a number of other officials.

The Croydon-Eindhoven service is an entirely new one and represents the first direct link between London and the industrial southern area of Holland. Using DC-3s, the service will in future operate once daily in each direction between London, Eindhoven and Maastricht (Beek). The single fare from London to Eindhoven is £9 and to Beek £9 13s.

The inauguration of this service represents yet another link in the long association of K.L.M. with Croydon Airport. It was at Croydon that K.L.M.'s first service to London landed on May 17th, 1920.

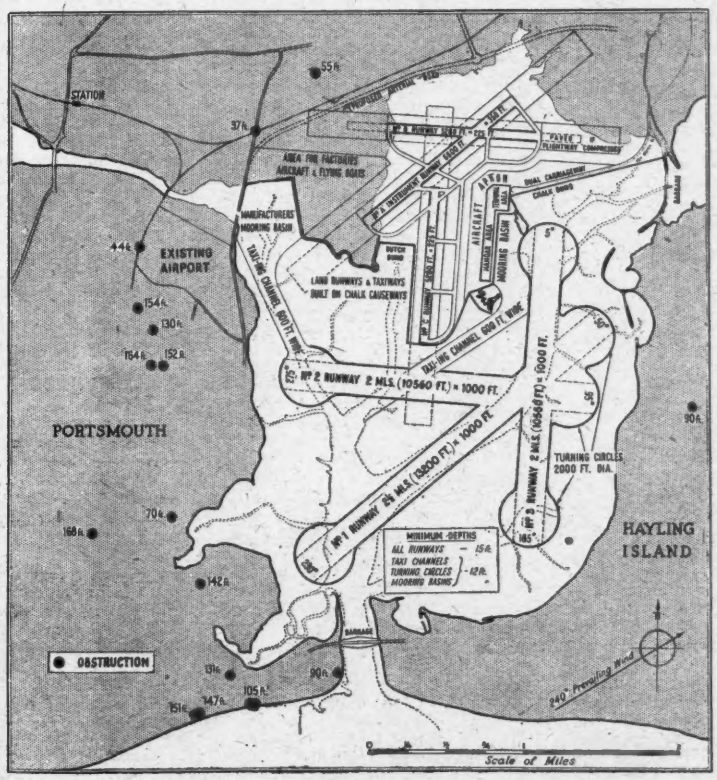
RADIO FOR THE DOVE

THE need for reducing both the weight and bulk of ancillary equipment in small feeder-line aircraft such as the Dove has been directly responsible for the development of some interesting new Marconi equipment. This was designed and produced, we understand, in collaboration with De Havillands and at their request, but it will appear in other transports.

The equipment—type AD.97/108/7092—provides W/T and R/T services in medium- and high-frequency channels, with navigational facilities in medium- and low-frequency channels. The complete installation weighs less than 100 lb in its application to the Dove, and this low figure has been made possible by the use of miniature valves and other components, by simplification generally, and by the use of a new system of rack-type dashboard mounting. The equipment also permits intercommunication, and it can be operated either by a first or a second pilot. The rack-mounting system has been made possible by a standardisation of dimensions and fixing points. The receiving set has been arranged so that the D/F loop can be either operated manually or converted to provide automatic radio compass indications.

SELECTING A BASE

A COMMITTEE has been appointed to review the proposals received from various sources for the establishment of a permanent flying boat base in the United Kingdom. This announcement was made by Mr. Ivor Thomas in the House of Commons on May 30, and he expressed the hope that the committee would be able to review these various proposals and the supporting data, and to make a report before the end of this month. The committee is composed of Lord Pakenham (chairman), Air Marshal Sir Leonard H. Slatter (A.O.C.-in-C. Coastal Command), Major R. H. Thornton (on behalf of B.O.A.C.), and Mr. Arthur Gouge (representing the constructors of the Saunders-Roe flying boats ordered by the Government).



At the same time Mr. Thomas indicated that a decision had already been taken on the various proposals for an interim base. This seems to rule out any possibility of the use of Southsea as in the scheme described in *Flight* on May 30. Apparently the move to Southampton is definite.

In the meantime, Portsmouth Corporation has forwarded to the Ministry of Civil Aviation the latest proposals for a combined Portsmouth airport and flying boat base at Langstone Harbour. The Langstone Harbour scheme has been dealt with at length in these columns on several occasions since it was first mooted before the war. The latest scheme is a rather more simplified edition, and the details of it and the general layout of the proposed airport and marine base can be seen in the accompanying diagram.

Amongst the chief claims made for the scheme are that, although considerable dredging would be required initially, the spoil from the operation could be utilised to assist reclamation of new land for the airfield, and that, as only a few acres of marshland would need to be taken over for the airfield site, no existing agricultural land would become sterile. The construction of the new airfield would presumably release for other purposes the land occupied by the existing Portsmouth Airport.

The scheme depends primarily on the provision of a barrage at the entrance to the harbour in order to raise the water within the basin and maintain it at a constant level.

CIVIL AVIATION

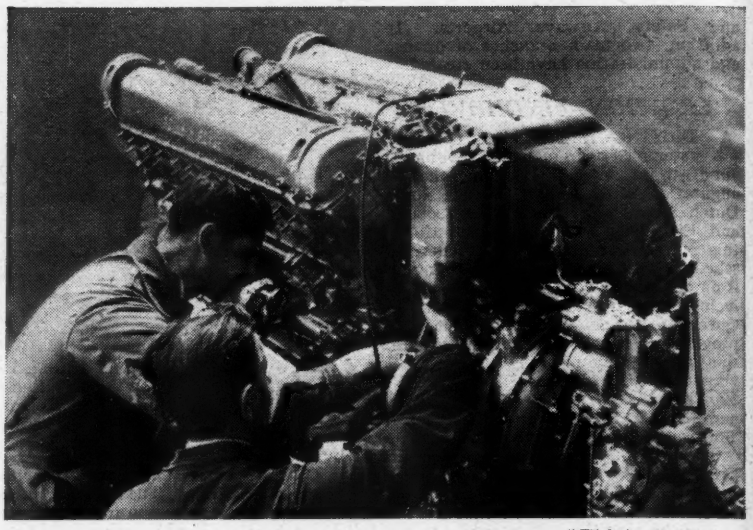
It was the necessity for this barrage, and the expense involved, which caused most difficulty before the scheme was shelved temporarily upon the outbreak of war. However, now that the provision of a flying boat base is a matter for the Ministry and for the country generally, the problem of expense is no longer the major issue.

In *Flight* last week we mentioned various locations which the Ministry had under consideration, and it seems clear that, whatever site is chosen, a good deal of constructional work and expense will be involved. In these circumstances, the Langstone scheme stands as good, if not a better, chance of final selection than many of its competitors.

RUNWAY SHORTENING

ACCORDING to a reply in the House of Commons recently by the Minister of Transport, the effective length of the NE-SW runway at Northolt is to be reduced so that, about mid-July, West End Road, Ruislip can be opened fully to road traffic. In the meantime navigational aids on "another" runway will be completed to enable that runway to be used more frequently than at present.

It seems a pity that, as Northolt is London's terminal airport for the British European Division's services, a somewhat more explicit reply could not have been given to an important question of this nature. With a statement of the kind made which contains so little precise information, it is not easy to understand why the presence of navigational aids on one runway should compensate so readily for the shortening of an entirely different runway.



"Flight" photograph.

CIVIL POWER PLANT: The first of the Rolls-Royce Merlin 620 series on the production line at the company's factory at Derby. The 620 series will be the power units for the Canadian-built DC-4s and for the Avro Tudors.

Private Flying

SELLING THE SOKOL

IN *Flight* of May 16th we published a photograph and some details of the new Czechoslovakian Mráz Sokol cabin aircraft designed primarily for private-owner flying. In pre-war days the Benes-Mraz aircraft were handled in this country by Aircraft and Allied Enterprises, and we hear that this concern still holds the agency for the types and that one of the new Sokols should soon be in this country for demonstration purposes.

The Sokol, which is a direct descendant of the Be-555, is a side-by-side seater cabin monoplane with a retractable undercarriage. It is powered by a 105 h.p. Walter Minor III, which gives it a maximum speed of a little over 150 m.p.h. It is available in two-seater and three-seater forms, and though the price in England has not yet been fixed, it is hoped that it will be sold for something under £1,400 with full equipment. Aircraft and Allied Enterprises are at 10, Hobart Place, Eaton Square, London, S.W.1.

BRISTOL GLIDING

THE organizers of the reconstituted Bristol Gliding Club have now secured the necessary site and have obtained one or possibly two gliders with which to start operations. *Ab initio* training was due to start on June 1, using a new Kirby Cadet at an airfield within eight miles of Bristol. For the benefit of those who have not seen previous references to this club the address of its organizing secretary is 9, Royal Park, Clifton, Bristol, 8.

B.G.A. COMMITTEES

FOR 1946 there will be three committees in the British Gliding Association to deal with the various problems concerned in the training of glider pilots and the organization of the pastime generally. The first of these, with Mr. K. G. Wilkinson as chairman, will deal with technical points such as strength and aerodynamic requirements, the specifications of launching equipment, instruments and parachutes and certificates of airworthiness while acting as advisers to the A.R.B. The second, with Mr. P. A. Wills as chairman, will be the flying committee, which is responsible for recommendation on methods of training, on safety regulations and on competition organization. The third, dealing with research and with Mr. J. W. S. Pringle as chairman, will look after more theoretical aspects and make arrangements for the carrying out of necessary research programmes.

The chairman of the B.G.A. for this year is Professor D. Brunt, M.A., and the vice-chairman is Mr. P. A. Wills, C.B.E.

NEWS FROM THE CLUBS

NOW that they have obtained two Tiger Moths and a Magister from the Ministry of Civil Aviation's allocation, the Portsmouth Aero Club is hoping to begin operations again in the very near future. Unfortunately, the clubhouse at the Portsmouth Airport, which was taken over for other purposes during the war, has not yet been returned to the club, and so a meeting of members due to be held at 7.15 p.m. on June 5th at the A.T.C. headquarters in Portsmouth. Dr. F. Mundell, a director of the club, tells us that the records were destroyed during the blitz. Past members are therefore advised to get into touch with Mrs. Coath, who is acting as Honorary Secretary, and whose address is Brunswick House, Bedhampton.

* * *

The flying charges at the Fair Oaks Aero Club at Chobham have been reduced to £4 an hour for dual and £3 an hour for solo on Tiger and Gipsy Moths.

* * *

The Wolverhampton Aero Club, with headquarters at the Municipal airfield, is getting back into its stride. One Auster and three Miles Magisters are immediately available, and, through its association with the Derby Aero Club, a Proctor, Monarch and Rapide are also available. The Club is operated by the Wolverhampton Flying School, an associate company of Air Schools, Ltd., of Derby.

* * *

Ex-A.T.A. pilots and others will be glad to know that the mess at White Waltham is still open. At the beginning of the month the West London Aero Club started operations from this airfield.

* * *

The Weston Aero Club—one of the Straight Corporation series—was due to restart operations at Weston-super-Mare on June 7th. The rates are £3 an hour for dual and solo on all types in the fleet—which will eventually consist of Hornet Moths, Magisters and an Auster. At the moment only the Hornet Moths are available.

ARCHIMEDES SOLVED THE PROBLEM

ARCHIMEDES (C.287-212 B.C.)

Most celebrated of the ancient mathematicians, Archimedes discovered the principles of the lever and of specific gravity. Invented a number of ingenious mechanical contrivances including the famous archimedean screw. Many of his solutions to scientific problems are still regarded as of the highest importance to-day.

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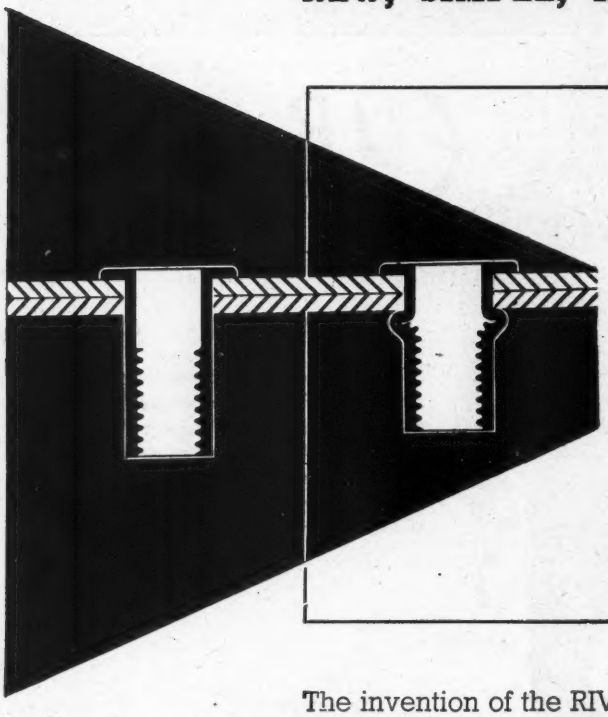
NEW, SIMPLE, REVOLUTIONARY!



Blind RIVET and Permanently fixed NUT Combined in the RIVNUT

The invention of the RIVNUT constitutes an entirely new and ingenious approach to fastening problems. The RIVNUT is an internally-threaded and counter-bored rivet which can be installed from one side of the workpiece. The RIVNUT is not only a perfectly balanced blind rivet when upset, but the threaded portion provides a permanently fixed nut as well, so that further attachments can be made from the work-face, with a screw or bolt.

Rivnut

A booklet on the RIVNUT, giving many details and enabling you to study the many uses and applications of the RIVNUT with regard to your own interests, has just been published. Linread (Advisory Service) will also gladly advise you on any fastening problems you would like to discuss. Please write for this booklet to Linread Limited, Department RE Sterling Works, 26-33 Cox Street, Birmingham 3.

THE NEW BLIND SCREW FASTENING METHOD

Recent Aerodynamic Developments

IN the first part of the 34th Wright Memorial Lecture given by Mr. E. F. Relf and published in last week's issue, the lecturer dealt with developments in laminar flow and boundary layer control. In the second half, concluded here, the quest for higher speed and the conditions of supersonic flight are considered.

PART II

(*Continued from page 579*)

By E. F. RELF, C.B.E., F.R.S., F.R.Ae.S.

THE recent developments in aerodynamics so far considered relate primarily to aircraft of moderate speed, and are endeavours to progress still further in the direction of drag reduction. I come now to very different aerodynamic phenomena which are concerned with the effects of the compressibility of the air when speeds become comparable with that of sound.

Let us consider broadly what is known of aerodynamic phenomena when the compressibility of the air, rather than its viscosity, is the main factor, say roughly at speeds greater than seven-tenths that of sound. Since the problems of aerodynamics at speeds well in excess of that of sound are in some respects much simpler than those quite near the sonic speed, whether above or below, I propose to say a little about "supersonic" aerodynamics first, and then to return to the so-called "transonic" region, which presents the most difficult problem of all.

The advent of the jet engine and the development of rocket propulsion have made flight at speeds above that of sound quite feasible. It is well known that the drag coefficient experiences a very rapid rise near the speed of sound, but that well above that speed it falls again gradually.

Many years ago Sir Thomas Stanton made a three-inch supersonic wind tunnel at the N.P.L. and tested aerofoils even to the extent of determining the pressure distribution over models of only half an inch chord. About this time Ackeret stated the theory of thin sharp-edged supersonic aerofoils now generally known by his name, and G. I. Taylor restated it for the benefit of English-speaking readers and compared its predictions with Stanton's experimental results.

This theory is a first approximation to the solution of the full equations of

Best aerofoil shape for a given thickness is a double-wedge section.

flow and has proved to be a very good approximation for thin aerofoils, provided the Mach number is well above unity. It is merely the statement that the pressure at any point on the aerofoil surface is proportional to the angle between the tangent at that point and the direction of motion, the constant of proportionality being a function of the Mach number only.

A number of important deductions follow at once. The lift coefficient is proportional to the angle of incidence and is independent of the shape of the aerofoil. Thus camber has no effect at all on lift, in marked contradistinction to its effect at low speeds. The lift slope decreases as the Mach number increases. The centre of pressure is at the half-chord instead of approximately at the quarter-chord point. The drag coefficient depends on the integral round the contour of the square of the angle between the tangent and the direction of motion, and it follows that for similar shapes the drag coefficient at zero lift decreases as the square of the thickness-chord ratio instead of being nearly independent of this ratio as it is at low speeds.

The best shape for a given thickness

Aspect ratios approaching unity can be used without serious drag being encountered.

is a double wedge, whose drag is three-fourths that of a bi-convex section formed of circular arcs. The maximum lift-drag ratio of the double wedge (neglecting skin-friction drag) is equal to half the reciprocal of the thickness-chord ratio, and occurs when the front part of the upper surface is exactly along wind, that is, when the angle of incidence is equal to half the angle of the wedge. Thus a section of 5 per cent thickness has a maximum lift-drag ratio of 10, and it is at once evident that the supersonic aerofoil, if sufficiently thin, can provide aerodynamic efficiencies of at any rate the same order as those to which we are accustomed at low flight speeds.

Further development of the theory of supersonic flow round an aerofoil brings to light other marked differences from the low-speed subsonic behaviour. It appears that aspect ratio is of much less importance in supersonic flight, and that quite small aspect ratios, of the order of unity, can be used without serious drag being encountered. Another important fact is that the customary downwash directly behind the aerofoil has almost disappeared, the air having downward momentum to balance the lift being only that confined between the shock waves springing from the leading and trailing edges. If we imagine a conventional aircraft with a tailplane, both recession of the centre of pressure to the half-chord point and the removal of the downwash at the tail tend to make the aircraft more stable in supersonic flight than at low speeds.

We are also able to learn something about control characteristics. Thus the simple Ackeret theory tells us that the ratio of the lift change due to unit control angle, to that due to unit incidence change is merely the ratio of control chord to wing chord. We thus find that the behaviour of control surfaces of the conventional kind is of the same nature and the same order of magnitude as in low speed motion.

The drag coefficient of fine pointed bodies of revolution has been studied theoretically, notably by Lighthill. Here we are not on such secure ground as in the corresponding two-dimensional problem of the thin wing, as there is evidence from experiment that the boundary layer separates from the surface on the tapering tail-end of the body. If it did not separate, the drag coefficient expressed on projected frontal area would, for the best shapes, be about ten times the square of the reciprocal of the fineness ratio and, to this approximation, is independent of the Mach number. If we take, very roughly, a fineness ratio of ten, and a wing area ten times that of the maximum cross-section of the body, the body drag comes out about equal to that of a 5 per cent thick wing at zero lift at a Mach number of 1.4.

The outcome of all this elementary and somewhat sketchy reasoning is that the aerodynamic behaviour of an aircraft of conventional lay-out, but with a considerably thinner wing than usual, is not in any way strikingly different at supersonic speeds from what it is at speeds of to-day. In other words, there is no fundamentally different feature in the aerodynamic behaviour which suggests any major difficulty in flight at supersonic speeds. The aerodynamic problems

Aerodynamic behaviour of aircraft not much different at supersonic speeds than at subsonic speeds.

involved are, in fact, simpler than those at sub-sonic speeds, and sufficient information exists to enable a reasonable design to be elaborated. It is not pretended that such a design would closely approach the best possible for a supersonic aircraft; the point is merely that, given sufficient thrust from the propulsive mechanism, there seems to be no aerodynamic reason why a successful supersonic aircraft should not be achieved very soon.

The theory of supersonic flow has been developed considerably beyond the simple concepts I have just stated. Some of this development is quite old, such, for instance as the Prandtl-Meyer theory of expansion round a corner, the work of Taylor and Maccoll on the flow around a circular cone, and that of Büsemann on flow around aerofoils, including his special form of biplane which should have no shock wave drag at one particular Mach number. These theories have been considerably extended in recent years and have provided a fairly complete statement of the supersonic flow around simple shapes like the thin aerofoil and the pointed body. They have also shown exactly what are the limita-

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tions and degrees of approximation of the simpler theories, such as that of Ackeret for thin aerofoils.

Experimental verifications of the theoretical predictions are rather scanty, especially with regard to the behaviour of aerofoils of finite span, mainly on account of the lack of supersonic wind tunnels of reasonable size. There are only two such tunnels in this country and neither of them has been in use for very long. One is the eleven-inch continuous-flow tunnel in the Engineering Division of the N.P.L., which has been mainly used for work on projectiles, while the other is a one-foot injector-type tunnel in the Aerodynamics Division. This latter is the original high-speed tunnel running on the compressed air supply of the N.P.L. compressed air tunnel, and provided with supersonic effusers in place of the original parallel intake. It has been used, in its supersonic form, for a preliminary study of the characteristics of two-dimensional aerofoils, and an example of the results is given in Fig 10.

This diagram exhibits the lift and drag characteristics of a double-wedge aerofoil and a comparison with the deductions from the simple Ackeret theory, which is shown to be a very good approximation when the Mach number exceeds about 1.2. In the drag diagram an allowance has been made for skin friction, which is, of course, absent from the theoretical prediction.

No serious experimental work has yet been done on three-dimensional models, such as those of complete aircraft. A larger tunnel is badly needed for such work, and the development of the experimental technique will take some time, not the least difficult point being the method of supporting the model without undue interference with the flow around it. The eleven-inch tunnel mentioned above has recently been used to determine the pressure distribution on short aerofoils mounted on one wall and has so provided some experimental data on the effects of aspect ratio.

We have, in the supersonic field, a well-developed theory and we may be very thankful for this; it will help us along the right path until we can build experimental equipment to study those problems which arise in practice and are usually too complex for theoretical treatment in detail. One such is the whole question of skin friction in supersonic flow, or, in other words, the relative importance of Mach number and Reynolds number in defining aerodynamic behaviour. Even here we have already some indications, and we shall not be far wrong if we assume the ordinary low speed skin-friction laws to be true and add the drag they predict to that arising from the shock-wave system.

Max C_L with full control will settle supersonic operating conditions.

What will the supersonic aircraft of the future look like? This is not an easy question to answer, but some trends are fairly apparent. It will certainly have very thin wings, and if it has a body at all, in the conventional sense, that body will be as long and thin as it can conveniently be made. In fact, "thinness" seems to be the key to low supersonic drag.

The aspect ratio will probably be quite low, though whether the wings will be heavily swept-back or not is at present a moot point; we do not know enough to predict with any certainty. I shall have more to say on the effect of sweep-back when I come to consider very high supersonic speeds, where this effect seems likely to be definitely beneficial. The problem will be to obtain enough stowage space without sacrificing the slim lines that are necessary for reasonably low drag.

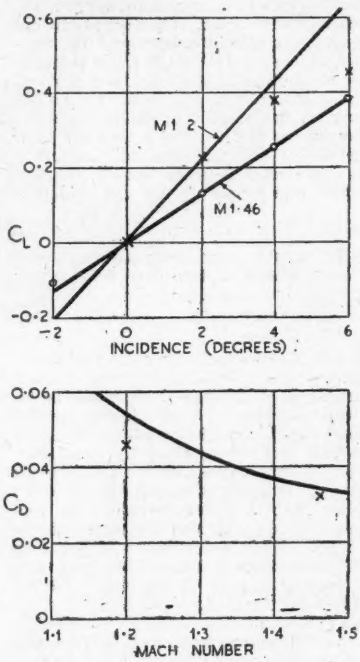


Fig. 10. Lift and drag curves of double-wedge supersonic aerofoil in comparison with Ackeret's theory

Whatever form the supersonic aircraft ultimately takes, it will almost certainly differ greatly from that of present-day machines, and one problem which will arise is that of control at low speeds during take-off and landing. I have already suggested that boundary layer suction may provide the key to the attainment of sufficient lift on thin wings, but the control problem may prove very difficult if the aspect ratio is very low.

Fortunately we have the means to study this point in our present large low-speed wind tunnels, and it would be of much interest now to carry out low-speed experiments on the unconventional forms that appear likely to be suitable for supersonic flight in order to see if their low-speed control problems can be satisfactorily solved. The point is an important one since the maximum lift coefficient attainable *with full control* will settle the supersonic operating conditions to a great extent. A little arithmetic shows that if the aircraft is to fly at an incidence near that at which its lift-drag ratio is a maximum, either the wing loading must be considerably higher than present-day figures or else the operating altitude must be much greater. The former alternative makes the landing problem more difficult while the latter has obvious difficulties relating to pressure cabins and engine performance.

Perhaps it is too early even to speculate on such things; the first problem is to get off the ground and attain supersonic speed. When that has been done, and we have experience of the new conditions of flight, we shall be more ready to face the detailed question of how to design the best form of supersonic machine and how to specify its best operating conditions. This brings me naturally to what is probably the most difficult problem aerodynamicists have yet had to face: What happens in the so-called "transonic" region, in the immediate neighbourhood of the speed of sound?

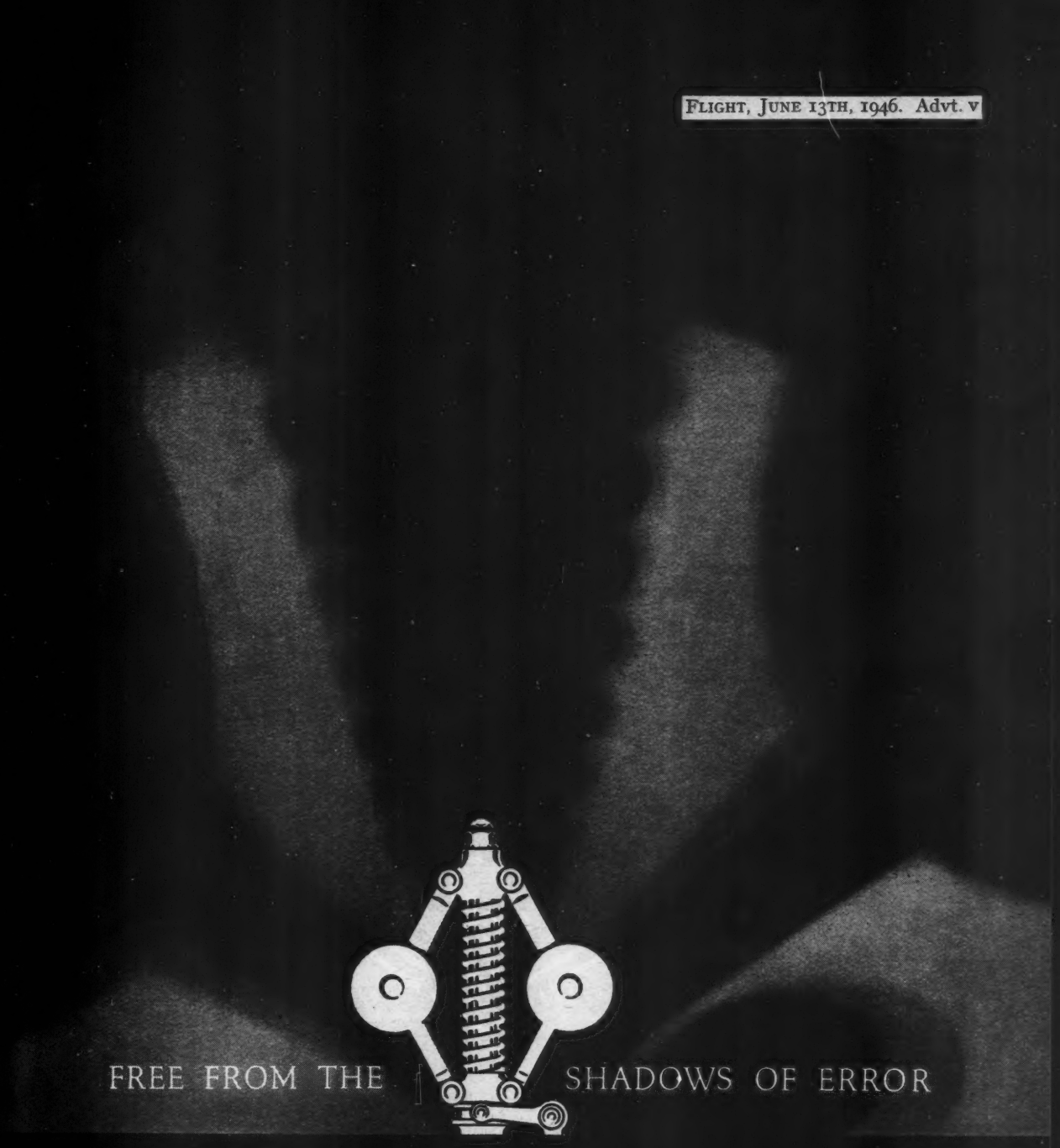
In recent years much information has been accumulated on aerodynamic behaviour at high subsonic speeds. The necessity for this was forced upon us by the ever-increasing speeds of aircraft, for although until very recently aircraft could not fly *horizontally* at speeds high enough to make compressibility effects important, they could and did dive at such speeds, and troubles that were met, particularly with the controls, made it imperative to study the phenomena involved.

Wind tunnels of little use for "transonic" region experiments.

Most of the basic facts are now so well known that I need not describe them in any detail. Suffice it to mention that at a given incidence the lift coefficient increases at first with the Mach number, but later falls abruptly; the drag coefficient remains nearly constant at first, but above a certain Mach number, dependent mainly on "thickness," rises very rapidly, while the pitching moment can exhibit a variety of behaviours, varying from almost complete insensitivity to very violent changes in either direction, depending on the wing shape, wing camber and relative position of wing and tailplane. Any of the more violent changes occur at a Mach number somewhat greater than the so-called critical Mach number, which is that at which the local speed of sound is first reached at some point in the field of flow, usually near the point of maximum suction on the wing.

This leads to the general conclusion, well borne out in practice, that no trouble is likely to be experienced from compressibility effects as long as the speed of flight is below that corresponding to the critical Mach number. Since the increment of velocity when the air flows round a body is least when the body is thin, we should expect "thinness" to be good for high subsonic speeds, just as we have seen that it is at supersonic speeds.

This expectation is realized in practice; for example, the Spitfire is one of the few aircraft that have given no trouble in fast dives, and it is a particularly "thin" aircraft. But the matter cannot be dismissed as simply as this; the more nearly we approach the sonic speed the more likely we are to



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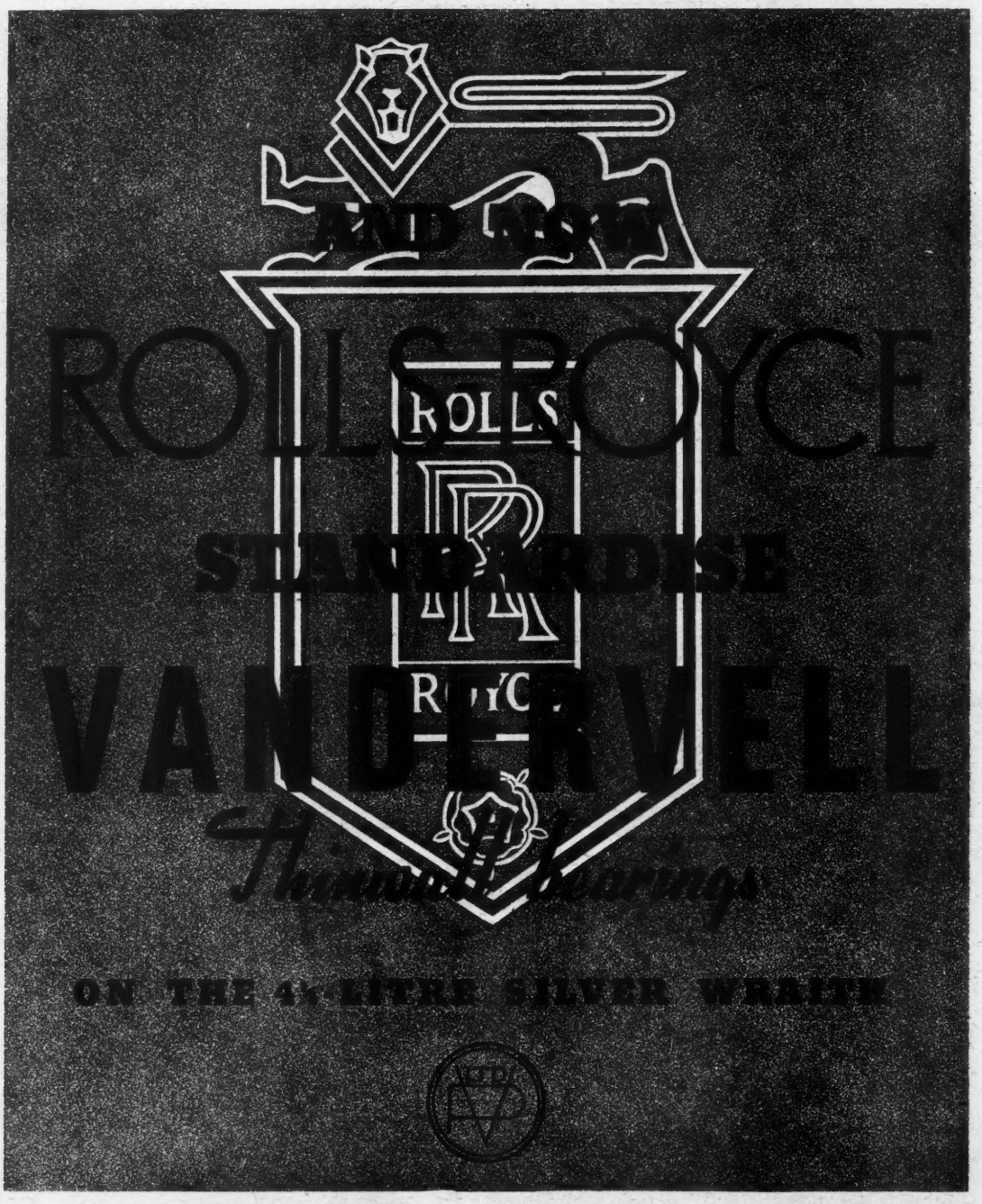

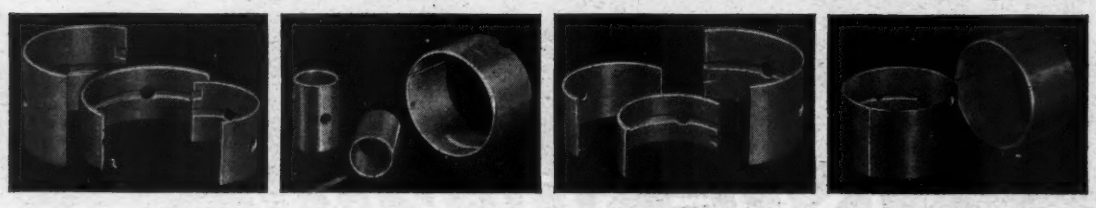

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encounter difficulties, and the greater is our ignorance of the precise nature of those difficulties.

One reason for ignorance is that it is not possible effectively to use the wind tunnel to acquire knowledge in this region. High-speed tunnels can be used up to a Mach number of about 0.85, but if we attempt to go higher, they "choke," as we say. This means that the Mach number in the neighbourhood of the model rapidly increases to unity and a shock wave extends right across the air stream. The reason for this behaviour is not far to seek.

If the relation between the Mach number and the cross-sectional area of a stream-tube is calculated, it is found that near a Mach number of unity the area varies exceedingly slowly. Thus, for the 10 per cent change of Mach number from 0.9 to 1.0, the change of area of the stream-tube is only 0.9 per cent. The flow is thus in a very critical state when the speed is close to that of sound.

Even if an empty tunnel could be persuaded to run at, say, M=0.95, the introduction of even a very small model would choke it, because of the change of cross-sectional area of the stream brought about by the model. As Dr. Hilton graphically puts it, the size of the model that can be used shrinks to zero as the speed reaches the sonic speed and then grows again as the speed increases above that of sound. Hence the wind tunnel is of little use in a range of Mach number from about 0.85 to 1.15. Yet we must fly through this range if we are to attain supersonic speeds, and so we must seek means of investigating aerodynamic behaviour in this range.

The obvious answer is to move the model through the air, instead of blowing an air current over the model. One way of doing this is to drop heavy bodies from a great height and to make observations on them by means of internal instruments communicating with the ground by radio or salved after the fall, or by external observation such as is provided by radar tracking. This line of attack is being explored, and some few observations have already been obtained. A second way is to project a model through the air by means of a rocket and to use similar methods of observation. This also is being developed.

The last way is by flight itself, but it is evidently unwise to proceed far in this direction, on account of possible unexpected dangers, until something has been learned by the use of pilotless models. The second method is, of course, precisely that used in ballistics, and it is significant that the drag of shells is the only aerodynamic quantity which has hitherto been measured accurately over the whole range of speed from zero to more than three times that of sound.

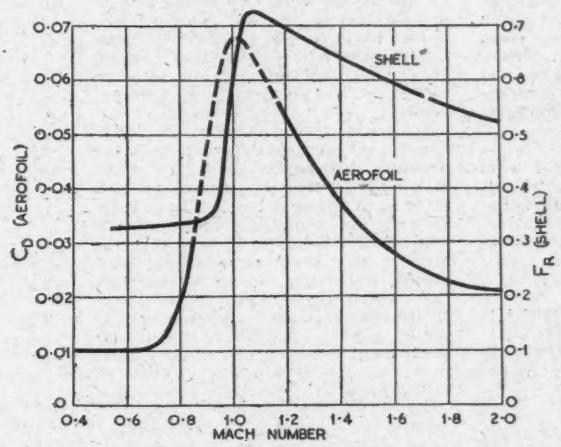

Fig. 11. Comparative drag curves against Mach number for supersonic aerofoil and shell.

I have already said that we know a good deal about aerodynamic phenomena at speeds well above that of sound. It is instructive to see how much we can guess of what will happen close to that speed from our knowledge of what happens well below and well above it. I have prepared three diagrams to illustrate this point.

In the first of these, Fig. 11, we have the drag curve of a typical supersonic aerofoil over the whole range of speeds for which it is known, there being a gap between the Mach numbers of approximately 0.8 and 1.2. On the same figure is shown the established drag curve for shells. It is evident that we can make a very reasonable guess as to how the aerofoil drag curve will behave in the unknown region near the sonic speed; the dotted part of the curve is my own guess. But if we plot the slope of the lift curve instead of the drag, as is done in Fig. 12, we find that guessing is quite out of the question, nor have we in this case any rough guide from ballistic experiments.

In Fig. 13 I have shown the elevator angle to trim as a function of Mach number for two aircraft. The subsonic values were measured in flight at the R.A.E.; the supersonic values were estimated by theoretical considerations and are certainly of the right order. Again it would be a bold man who thought he could join the two parts of the curve with any real degree of assurance.

We are thus driven to the inexorable conclusion that only by experiments of the kind I have suggested can we learn enough to make the design of aircraft for flight in or through the transonic region a safe procedure; we cannot guess the answer from what we already know, except possibly in the case of the drag coefficient. It is thus necessary to develop a new and very difficult experimental technique if we wish to put our knowledge on a firm basis. It may not prove very difficult to measure simple things like drag, but the detailed study of such things as control characteristics on a free projected model moving at about 700 miles per hour may well tax our ingenuity to the utmost.

There is also the still more difficult problem of flutter in the transonic region. Even in the range of high Mach number covered by the wind tunnel nothing has yet been done to study this important subject, because of the utter inadequacy of the number of high-speed tunnels now available.

This matter of the transonic region is urgent. It may be some time before aircraft are developed which fly through the region and attain supersonic speed, but our present-day machines can get very nearly up to the speed of sound in a dive. It is now quite a long time since a Spitfire attained a Mach number in the neighbourhood of 0.9; and the development of jet propulsion, together with continued aerodynamic improvement of design, may be expected to increase this figure. With conventional designs of aircraft, however, the increase is slow, because of the extremely rapid rise of drag near the sonic speed.

But is this rapid rise of drag unavoidable? We are beginning to think it is not, or at least that it can be put off till a still higher Mach number is reached, possibly a supersonic one. Very little is known, basically, about drag in the region well above the critical Mach

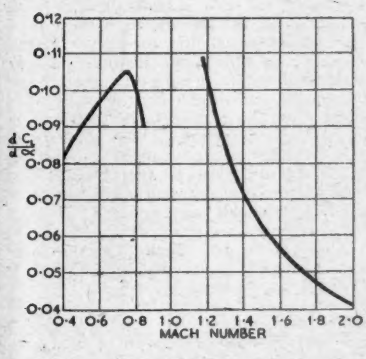

Fig. 12. Slope of lift curve of supersonic aerofoil.

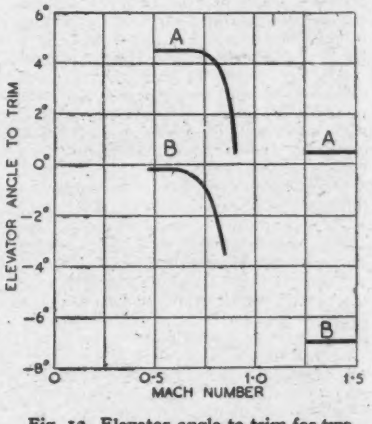

Fig. 13. Elevator angle to trim for two different aircraft A and B. Subsonic values measured, supersonic estimated

number but still below unity, for theory has so far failed to provide solutions to flow problems where parts of the field are subsonic and other parts supersonic.

We know from experiment that a shock wave first forms near the point of maximum suction of the wing; that the shock wave becomes "stronger" and moves back on the chord as the Mach number increases; and that at supersonic speeds it reaches the trailing edge and is accompanied by another shock wave springing from the leading edge. But we have not yet evolved a theory which will predict these changes and give information on the strength of the shock wave and the resultant forces in any given condition.

We are, therefore, forced to rely on experimental evidence, and, as I have already pointed out, at present this is restricted severely by the limitations imposed by the wind tunnel. We know, however, that different wing sections behave in different ways in the high subsonic region, and in particular that a

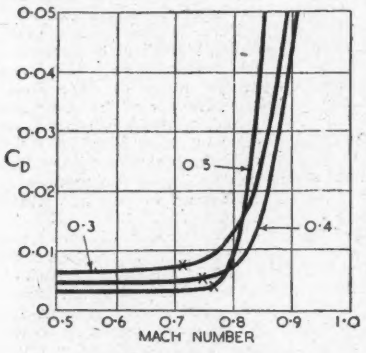

Fig. 14. Drag curves for three aerofoils showing that critical Mach number is no guide to super-critical behaviour.

high value of the critical Mach number does not necessarily imply the best behaviour at still higher Mach numbers.

This is illustrated in Fig. 14, which shows the drag curves of three symmetrical aerofoils having their maximum thickness at 0.3, 0.4 and 0.5 chord respectively. The critical Mach numbers are indicated by crosses and it is seen that the order of these critical numbers is no guide to the order of the curves above a Mach number of 0.8. In fact, the aerofoil marked 0.5 has the highest critical but is nevertheless the worst of the three at the higher Mach numbers.

A few results for cambered aerofoils are available and these suggest that symmetrical sections are the best at Mach numbers well above the critical, especially when the maximum thickness is set at about 0.4 chord. It thus appears that symmetrical sections are likely to be very good for high subsonic speeds, not only on account of drag, but also because they give less violent changes of pitching moment.

There is another way in which much more striking drag reduction seems to be possible, and this was first brought to the attention of British scientists by a study of German work done in the war years. I refer to the effect on a large sweep-back of the wings, a subject which is uppermost in many minds at the present time.

There is a theoretical argument which

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indicates the nature of this effect. Consider the potential flow round a two-dimensional wing moving in a direction perpendicular to its leading edge, that is, with zero sweep-back. Now superimpose on this motion a velocity of the wing in the direction of its span. This will evidently have no effect on the pressure distribution, but the resultant velocity is now increased and is at an angle, as though we had given the wing a sweep-back.

When this theory came to our notice I looked up some old experiments on the pressure distribution over a yawed R.A.F.15 aerofoil of aspect ratio 6 made by Williams at the N.P.L. in 1928. Though the conditions are not two-dimensional, these tests show that the pressure at a given point at the mid-section of the wing does in fact fall with yaw roughly as the square of the cosine. (I instance this as an interesting example, and there are many, of a fundamental fact inherent in an old experiment, but which is not appreciated or explained until some new observation brings it forcibly to notice.)

When the speed of motion exceeds that corresponding to the critical Mach number, a more spectacular drag decrease is to be expected, for the theory suggests that we have reduced the effective *Mach number* of the section in the ratio of the cosine of the sweep-back angle. Thus if the critical Mach number of a thin section were 0.8 we might expect to be able to use it at a Mach number of unity without any compressibility drag rise if it were swept back through an angle of $\cos^{-1} 0.8$ or 37 deg.

This is such a surprising conclusion that a direct experimental verification of it would be very welcome. The theory is, of course, incomplete when applied to a real problem since it neglects viscosity, in the presence of which the spanwise component of velocity can obviously affect conditions in the boundary layer. We might expect, therefore, that drag at low speeds would not behave precisely as the theory indicates, but that shock wave effects, which depend rather on the pressure distribution than on the viscous forces, would very likely do so.

I can show you a little evidence from the rectangular high-speed tunnel at the

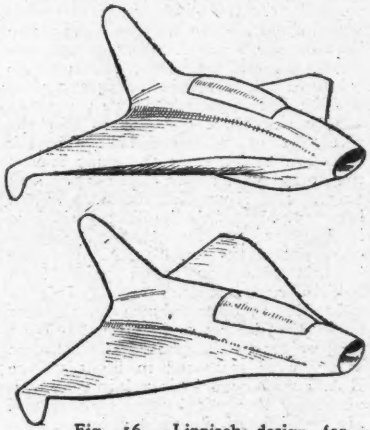

Fig. 16. Lippisch design for supersonic aircraft.

N.P.L., in which an aerofoil was tested for drag by the pitot-traverse method, first straight across the tunnel and then inclined at 45 deg. The curves, Fig. 15, show that something like half the predicted improvement was realized, as shown by the Mach number at which the drag rises rapidly. The failure to realise a greater gain may well be due to end effects, for the chord of the aerofoil was one quarter of the distance between the tunnel walls.

Accepting for the moment that the

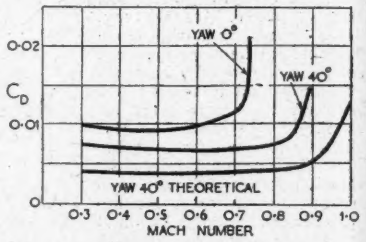

Fig. 15. Two-dimensional test of swept-back wing in N.P.L. rectangular high-speed tunnel.

two-dimensional theory would be borne out by a really two-dimensional experiment, there remains the question of how far the indicated gain can be realized when the aspect ratio is finite, and particularly when it is fairly small, as is likely to be the case for aircraft with rather thin wings. This question can only be answered by experiment and, again, we are confronted by the difficulty that the wind tunnel fails us just as we approach the speeds in which we are mainly interested.

The Germans had made some experiments of this kind. Their results show again that only about half the theoretical gain is realized, and this is attributed to the departure from two-dimensional flow at the centre and tips. It can easily be seen, by considering the combination of the varying chordwise velocity component with the constant spanwise component, that the flow near the centre section will be convergent, so that there is a tendency for high speeds and early shock stall in this region.

While arguments of the kind I have advanced suggest that very considerable increases of speed without drag coefficient increase may be obtained by using large sweep-back, the adoption of this device will involve the solution of other problems connected with sweep-back, of which perhaps the most serious is the tendency to earlier tip-stalling. This phenomenon is well known to designers of tailless aircraft and presents a major difficulty in obtaining adequate control and stability during take-off and landing. Obviously the difficulty will become greater as the aspect ratio is reduced, while the proportion of the theoretical gain in drag will, presumably, decrease. It would appear that there will be a best compromise between these two considerations which can only be arrived at by experiment.

The extent to which the Germans themselves have been led by arguments of this kind is illustrated well by Fig. 16, which shows a design for a supersonic aircraft by Lippisch. Structurally it should present no great difficulties; aerodynamically it is probably very good at high subsonic speeds and in supersonic

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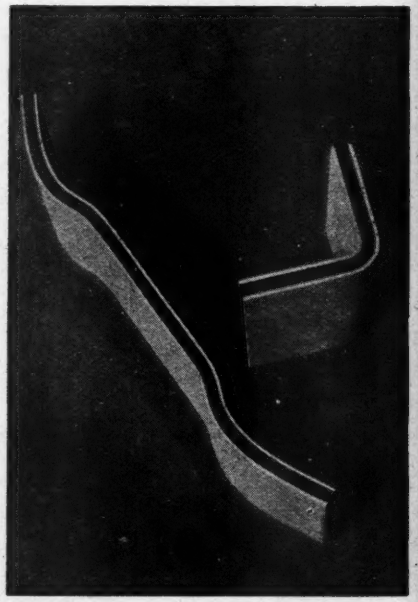
The frequent enquiries we are getting from all manner of industries tell us what a great post-war future awaits ONAZOTE II in all fields where *thermal insulation* and lightweight construction are of prime importance. ONAZOTE II, made entirely from high-grade synthetic rubber, is now fulfilling the demands originally satisfied by ONAZOTE I, a natural rubber product which is no longer available.



WHAT IS ONAZOTE II?

ONAZOTE II is an expanded hard synthetic rubber material with exceptional thermal insulating properties. It possesses mechanical and physical properties equivalent in every way to natural rubber and yet has the added advantage of a higher soften-point, thereby rendering it more suitable for use under tropical conditions. It is extremely light and buoyant, yet strong enough to meet all demands. It is non-warping and non-water-absorbent; bacteria and vermin proof; not subject to deterioration.

HOW IS ONAZOTE II USED?

ONAZOTE II is ideal for use as a low density stabilising core in the construction of deck-housings, partition walls, panelling, doors, furniture and interior fittings. Adhered in the well-known "sandwich" technique between wallboard, plywood veneers, aluminium, lightweight alloy sheets or other suitable material, it finds a place in flat or curved panel work. It can also be supplied in various moulded sections. As a buoyancy material it is particularly suitable for the construction of floats, mooring buoys, pick-up buoys and various types of life-saving appliances.

WHAT GIVES ONAZOTE II ITS LOW THERMAL CONDUCTIVITY?

The unique non-intercommunicating cellular construction of ONAZOTE II and its allied materials eliminates convection currents and thus provides an insulating medium of the highest known efficiency.

★ *There is probably a use for ONAZOTE II in* your *business. Please write or telephone us.*

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ER8

RECENT AERODYNAMIC DEVELOPMENTS

flight, but one can well imagine that it would present very considerable difficulties in attaining good control at low speeds. A little ordinary wind tunnel work on a design of this kind would give a useful indication of the practicability of such a revolutionary layout.

In summarising this part of my lecture I can safely say that the transonic region is at present the greatest unknown in the quest for higher and higher speeds of flight, and that it presents great difficulties of investigation owing to the fact that ordinary laboratory methods fail and we are being forced to develop a new technique. Here, indeed, is an almost virgin field for the research worker of the immediate future.

I make no apology for a few words on the subject of "engines" in a lecture on aerodynamic developments, for the jet-propulsion type of power plant involves aerodynamic problems at least as much as engineering ones. Moreover, its progeny, especially when they indulge in supersonic flight, may well become almost purely aerodynamic.

The efficiency of the combustion process in a gas turbine depends almost entirely on aerodynamic considerations. The compressor and turbine depend on aerodynamic reactions related to those of simple aerofoils, while the intake and ducting must be designed to minimize loss of energy by any breakaway of flow in them; they must be "internally streamlined," so to speak. Moreover, the air and gas speeds are high, so that the Mach number of the internal flow may often approach unity. It follows that general theoretical and experimental work on airflow at high Mach numbers now has a very direct bearing on the design of the engine as well as the aircraft.

When we come to supersonic flight speeds a curious position arises. The compressor of the jet engine becomes less and less a necessity as the speed increases because the compression of the air at the intake *due to the forward motion*, the so-called ram effect, becomes increasingly able to provide the pressure ratio required for the subsequent processes of combustion and ejection. If, for instance, we assume that there is a plane normal shock wave across the entry duct,

Rockets, radio and radar will provide supersonic data.

the pressure ratio is 3.65 at a Mach number of 1.5 and 7.85 at a Mach number of 2.0.

It is quite likely that these pressure ratios can be improved by designing the intake so that the flow just inside it is still supersonic, the pressure recovery taking place through one or more inclined shocks followed by a weak normal shock.

The "engine" to which these ideas lead is, in a sense, no engine at all. It is merely a duct in which aerodynamic and thermal changes occur, and it has been described as an aero-thermo-dynamic-duct, a somewhat lengthy word that some have contracted to "Athodyd" for convenience. The principle is precisely the same as that of the normal gas turbine except that the initial compression is now entirely due to ram effect, and so there is no rotating part at all. Since the compression increases with speed, so also does the thermal efficiency.

The one difficulty lies in the fact that the action *depends* on the forward speed; the "static" thrust is zero and the "take-off" thrust is negligibly small. The use of the athodyd for supersonic flight will thus involve some other source of power, possibly rockets, to accelerate the aircraft to a speed sufficient to allow the athodyd to begin work with reasonable efficiency. An alternative may be to carry normal gas turbines plus athodyds.

As far as I am aware no complete test of this new propulsive device has yet been made, save for a very tentative experiment on an athodyd about one inch in diameter in the twelve-inch supersonic tunnel of the N.P.L. The object of the test was to compare a measured thrust with that calculated. There is no reason to doubt calculated values, provided that the intake conditions are known, so that the right shock-wave formation at the intake can be used in computing the pressure in the combustion chamber. The

The bi-fuel rocket a possible useful way to study characteristics of supersonic flight.

difficulty is to be sure of these intake conditions, which are known to depend on the "effective blockage" in the duct due to the processes of compression, combustion and subsequent expansion to the outlet jet. Here, again, is a most interesting and fruitful field of research for the future.

Before concluding this brief reference to new means of propulsion I must mention the bi-fuel rocket, of the kind used by Germany in the V-2 weapon, and in a short-duration, high-performance fighter. It has the inherent disadvantage of high fuel weight, since the oxygen as well as the combustible must be carried, but its interest lies in the fact that it may well provide an easy way to make supersonic flights in experimental aircraft for the purpose of beginning to study, in the air, the new problems involved. This is because the high temperature that is possible in the short combustion chamber and exit nozzle allows the production of a far higher specific thrust than can be obtained in the same space from a gas turbine, while avoiding the difficulty of take-off associated with the athodyd. It provides, in short, a very high thrust which is almost independent of speed or altitude.

I shall be accused of not being up to date if I do not at least mention atomic energy! Needless to say, the possibility of a propulsive agent which involves an almost negligible weight would revolutionize all our ideas about high-speed aircraft. In fact, it would leave only one barrier to the attainment of almost any speed we wished: the barrier of temperature rise. This limitation may soon prove quite serious, even with methods of propulsion that we can now foresee.

As is well known, the surface of a body in motion is raised in temperature by very nearly the thermal equivalent of the kinetic energy, that is, by an amount $V^2/2Cp$ or its equivalent $M^2T/5$ for air, where M is the Mach number and T the absolute air temperature. Thus for a Mach number of 1.4 the rise is 85 deg C in the stratosphere, and for $M = \sqrt{5}$ the absolute temperature of the air is nearly doubled. It does seem that if almost unlimited power ever becomes available for propulsion, the limit to man's achievement in speed may finally be set by temperature.

In this lecture I have deliberately not gone into any great detail; I have tried, and I hope I have succeeded in some

Ultimate limit to man's achievement in flight speed is likely to be set by temperature.

small degree, to indicate the nature of the new ideas that have arisen recently in aerodynamic research, and to show what bearing they have on the future

In the past there have been periods in which the greatest advances came from improved engines, and others marked by great improvements in cleaner aerodynamic design. It looks very much as though the next period will be characterized by both, for we see glimmerings of the possibilities of drags far lower than anyone could have hoped for a few years ago, while on the engine side the recent marked successes of jet propulsion can only be the first-fruits of the new forms of power plant.

I do not believe there was ever a period in aeronautical history so bright with the possibility of future progress. I can only hope that we shall be wise enough not to allow the inevitable retrenchment after a long and costly war to hamper too seriously our research into the unknown. To my mind the one thing on which we should not cut down expenditure is research, for it is only by research that we can be ready to meet the demands of the future. Indeed I would be so bold as to suggest that we ought greatly to increase our research facilities for two very good reasons. One is that the war has produced so many urgent problems that we have not had time for the leisurely but very hard thinking, which constitutes the research method. The result is a surfeit of *ideas* arising in all manner of ways, but not followed-up or thought-out in detail. We are, therefore, behind-hand with the *implication* of these ideas, a process which will involve a lot of work by a lot of men.

The second reason is even more important. The researches arising from the ideas I have sketched in this lecture need, for their proper study, equipment of a kind which we do not possess in this country; equipment which, in some cases, is complex and costly. If we do not provide such apparatus, and that quickly, we shall lose a great opportunity for British aeronautical science.

Lastly, one other thing that I hope most fervently is that we may be able in the future to advance hand-in-hand with our great wartime ally and friend, the United States of America. Surely the continuance of the close co-operation which was so effectively established during the war years into the years of peace, would be the greatest tribute we could pay to those two great men who did so much to inaugurate the aerial age, and in whose honour we hold this Wilbur Wright lecture every year.

CORRESPONDENCE

The Editor does not hold himself responsible for the views expressed by correspondents. The names and addresses of the writers, not necessarily for publication, must in all cases accompany letters.

LONG-DISTANCE RECORDS

Another Liberator Claim

WITH reference to Flt. Lt. Gibson's letter (*Flight*, May 23rd) from South-East Asia of his squadron's longest sortie, perhaps he would be interested to know that a Liberator aircraft of the squadron which was engaged with my own on Special Duty Ops. carried out a sortie of 24hr 25min and covered a distance of just over 4,000 air miles, which, according to the *Times of Ceylon*, is the record for any land-based aircraft of the R.A.F. in any theatre of operations.

This sortie was also carried out by an aircraft operating from a jungle airstrip in Ceylon to Malaya, a journey which entailed flying for 22 hours over the sea.

The average a.u.w. of the squadron's aircraft was 66,000lb, using a 2,000yd runway, and the average "airborne" time for its aircraft was 22hr 30min and was often over 23 hours.

EX-S.D. "TYPE."

"WHY HELICOPTERS?"

Counter-claims of the Gyroplane

MAY I congratulate you on your commentary in "The Outlook" (*Flight*, May 23rd) which is the first published criticism of the present policy of developing the helicopter to the complete exclusion of the gyroplane with free windmilling rotor and airscrew propulsion that I have seen.

I have long held the opinion, based on piloting and design experience with this latter type of aircraft, and others, that we have in the "windmilling" gyroplane an infinitely more suitable and promising line of development for private owner use and short-distance commercial operation than is offered by the helicopter.

The ability to ascend vertically is surely poor compensation for the low power-loading, high parasitic drag and mechanical complication involved, unless specialized operating conditions demand this particular characteristic at the expense of all other considerations.

G. H. CUMBERBATCH WILLINS,
M.A., A.F.R.Ae.S.

MORE ABOUT THE HUDSON

Some Comments from an Ex-A.T.A. Instructor

I MUCH enjoyed "Indicator's" article on the Hudson. Especially as I put in as many as a hundred hours of instructional work on this type while in the A.T.A., where it was popular, and I am proud to believe that this was one of the few organizations which really knew how to operate the type. Considering that the great majority of our pupils had had no twin experience other than in Oxfords, the accident rate was very small. The Oxford is very similar to the Hudson in many ways, and we found that it made a good trainer for the latter; so much so that we frequently referred to the Hudson as the "electric Oxford."

In spite of a great deal of argument against it (chiefly from instructors who found it difficult) the three-point landing was insisted on at the A.T.A. A.F.T.S. This was purely so as to improve judgment and skill. If one lands a Hudson on three points eight times out of ten, one was not likely to have much trouble with anything else.

Some of the A.T.A. Hudsons could be made to three-point quite easily. The approach was made with a trickle of power right down to the hold-off, with flaps down to the stop and with full tail-heavy trim, at 80 knots. The *idea* was to get the thing into the three-point position with power still on, then, with a frantic heave, to pull the tail down while simultaneously closing the throttles. More often than not, when the time came, there was no longer any elevator control and the aircraft crumped on its wheels and bounced all over the airfield. But some of the Hudsons could be three-pointed quite effortlessly even off a glide approach. However, we had no illusions about the landings which our pupils would make when they had left the school. "Indicator" is absolutely right when he says that the wheeler was the surest and most comfortable form of arrival with the type.

The single-engined performance was remarkable. A colleague of mine had the misfortune to lose an engine while instructing, so he feathered the airscrew and told the pupil to carry out a single-engined landing at a certain large airfield. Unfortunately, the pupil overdid the overshooting and they had to go round again. He crawled about for miles while scratching his way up to about 400ft and flying at about 85 knots—but he made it.

The only snags we had with Hudsons were the shearing of tail-wheel locks, sometimes two or three a day, and leaky petrol tanks—the latter only on much-used aircraft.

EX-A.F.T.S. INSTRUCTOR, A.T.A.

DC-4 VARIATIONS

Use of the Name Skymaster

I READ in *Flight*, May 9th, that the K.L.M. opened a new service with a Skymaster (see p. 471). That is not quite right, for this new airline, Amsterdam-New York, which is called "The Flying Dutchman," is maintained by DC-4s, type 1009. The first of these aircraft was christened "Twenthe," and the second "Rotterdam." The other two will be here this month (May).

There is a pretty great difference between the Skymaster and the 1009. The Skymaster is a military version of the DC-4 and carries 28 to 36 passengers. The 1009 carries 44 passengers. The take-off weight of the Skymaster is 29,500 kgs, that of the 1009 33,100 kgs, and while the 1009 has four Pratt and Whitney engines of 1,450 h.p. each, the Skymaster has four of only 1,350 h.p. each.

I hope that, if I am wrong, one of your correspondents will correct my errors. A DUTCH BOY.

[Our young Dutch friend (whom we should like to compliment on his excellent English) is quite right in saying that the Skymaster is a military version of the DC-4, but the name is commonly applied to any version of the DC-4 basic type when there is no particular need to go into technical details. Similarly, the latest civil passenger version of the basic DC-3, as used by B.O.A.C., is still referred to as a Dakota, though the name strictly applies to the R.A.F. version which differs very considerably inside; but "A Dak's a Dak for a' that."—ED.]

ULTRA-LIGHT AIRCRAFT

Grounded by Official Muddling

I WONDER if any of your readers are in the same unfortunate position that I am at this moment.

Before the war I used to fly a Tipsy single-seater, G—AFVH. This machine, like all other ultra-light aircraft in the country was flown on a "Permit to Fly" and the C. of A. regulations were waived.

Now I want to get the machine flying again, but on writing to the A.R.B. for a permit I was told that no permits would be issued except for experimental aircraft, and that I must get a C. of A. As soon as I tried to get a C. of A. I came up against a brick wall.

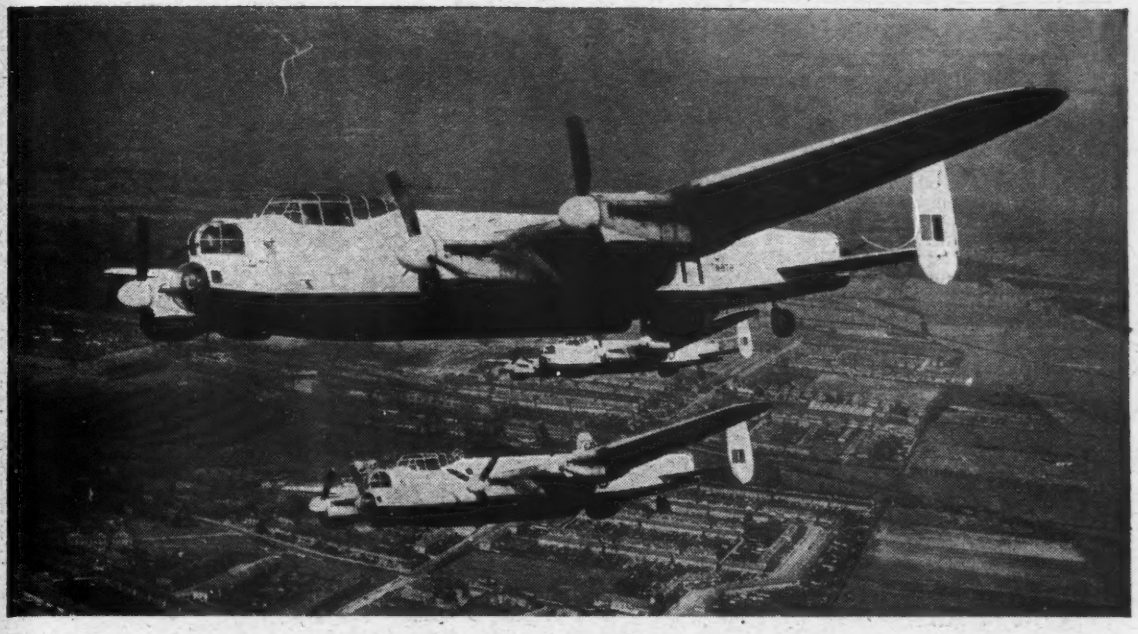
No C. of A. can be issued for an ultra-light aircraft because the engines used by these machines are non-approved engines. No approved engine can be fitted as there are none available of the required power. Also, in my case, the airframe is of Belgian origin, and on applying to the Belgian authorities for a copy of the original Belgian C. of A., I was informed that all documents had been destroyed during the Occupation and therefore they could not produce a copy.

I am therefore in the delightful position of being allowed to fly the machine as soon as I can get a C. of A., but under no circumstances may I have a C. of A.: and this situation is unaffected by however many replacements, overhauls, renewals, etc., that I may do to the machine.

Could anything be purer "Gilbert and Sullivan"?

I have been writing now for months to the Ministry of Civil Aviation about this business and I still cannot get any sense out of them. I have been up to London to see them, and I have written to Lord Winster asking for an interview, but "the matter is still under review." It has apparently been under review since at least January 1st of this year!

It is quite clear, to me at any rate, that this decision not to issue permits to fly has been taken by somebody who "hasn't a clue" as to its effect. If it has been taken deliberately, the whole matter becomes much uglier, as it means that the Government is out to kill the ultra-light aircraft movement despite the fact that these little machines were amazingly good and surprisingly cheap to fly. R. ALLEN.



ACTION ABROAD: Lancasters modified for long range service in the Far East are identified by larger intake ducts for the radiators, bulging bomb bays, and rear turrets with two .50 calibre guns. No. 35 Squadron, whose Lancasters are illustrated, have accepted an invitation to fly to America to take part in celebrations. *(See paragraph on this page).*

SERVICE AVIATION

Royal Air Force and Naval Air Arm News and Announcements

D.P.R. Appointment

AIR CHIEF MARSHAL SIR PHILIP JOUBERT, who retired from the R.A.F. in December last, has been appointed Director of Public Relations at the Air Ministry in succession to Air Comdre. Lord Willoughby de Broke. It is difficult to imagine a more popular appointment. Many will remember his exceptional broadcasts at the time of the Battle of Britain, and his charm of manner and command of the English language make him eminently suitable for his new task.

Sir Philip Joubert, K.C.B., C.G.M. D.S.O.

Hastings in Production

THE new particulars and photographs of the Hermes/Hastings prototype which appeared in last week's issue suggest that in the Handley Page Hastings Transport Command will have an aircraft of exceptional quality. Special doors on the port side of the fuselage will facilitate the loading of bulky freight and medium-sized vehicles, and the usefulness of the type should be greatly extended by its ability to tow heavy gliders. The Hastings is in quantity production and its imminent introduction into service means that the R.A.F. will have a freight and troop transport appreciably faster than current heavy bombers. Maximum and cruising speeds of the Hermes, from which the Hastings differs only in detail, are 355 m.p.h. and 300 m.p.h.

Auxiliary Air Force

AS briefly reported in *Flight* last week, the Auxiliary Air Force is being reformed with thirteen day-fighter, three night-fighter and four light-bomber squadrons which will form part of the first line post-war Air Force. Recruiting will be carried out by the individual squadrons, which will announce locally when they are ready to deal with applications, and for a while it will be confined to officers and men who have served previously with the R.A.F. and A.A.F.

Conditions of service are being drawn up, and in a number of cases Auxiliary officers who have served throughout the war are being invited to return to command their old squadrons. Each squadron will have a skeleton staff of regular officers, senior N.C.O.s and airmen who will act as instructors to the Auxiliaries and deal with the routine work of the unit.

All units will be equipped with operational aircraft, and for a start the day-fighters will have Spitfires and the night-fighters and light-bombers Mosquitos.

As in pre-war days, each squadron will have a town headquarters and operate from an airfield in the vicinity. Details of the 20 squadrons are as follows:—

500 (County of Kent) West Malling; N.F.; 503 (County of Gloucester) Filton, F.; 502 (Ulster) Aldergrove, L.B.; 504 (County of Nottingham) Syerston, L.B.; 600 (City of London) Biggin Hill, F.; 601 (County of London) Hendon, F.; 602 (City of Glasgow) Abbotsinch, F.; 603 (City of Edinburgh) Turnhouse, F.

604 (County of Middlesex) Hendon, F.; 605 (County of Warwick) Honily, N.F.; 607 (County of Durham) Ouston, F.; 608, (North Riding) Thornaby, L.B.; 609 (West Riding) Church Fenton, N.F.; 610 (County of Chester) Hooton Park, F.; 611 (West Lancashire) Speke, F.; 612 (County of Aberdeen) Dyce, F.; 613 (City of Manchester) Ringway, F.; 614 (County of Glamorgan) Llandow, F.; 615 (County of Surrey) Biggin Hill, F.; 616 (South Yorkshire) Finningley, L.B.

Lancasters in the U.S.A.

IT was reported in *Flight* on April 25th that the U.S.A.A.F. had invited the R.A.F. to send a squadron of ex-operational Lancasters to America, to take part in Air Forces Day celebrations on August 1st.

The invitation has been accepted, and No. 35 Squadron has been nominated to represent Bomber Command. The Lan-

SERVICE AVIATION

casters which flew in the Victory flight on June 8th are also from No. 35 Squadron.

The officer in charge of the operation will be Group Capt. R. C. M. Collard, D.S.O., D.F.C., Station Commander of Gravely, Huntingdon, and the Squadron Commander will be Wing Cdr. A. J. L. Craig, D.S.O., D.F.C. Flying in flights of four, the Lancasters will leave Gravely early in July, the route will be via St. Mawgan (Cornwall), Lagens (Azores), and Gandar (Newfoundland).

Ground crews to service the Lancasters during their stay will fly to America in Avro Yorks.

Roll of Honour

Casualty Communiqué No. 587.

THE Air Ministry regrets to announce the following casualties on various dates. The next of kin have been informed. Casualties "in action" are due to flying operations against the enemy; "on active service" includes ground casualties due to enemy action, non-operational flying casualties, fatal accidents and natural deaths.

Of these names in this list, 301 are second entries giving later information of casualties published in earlier lists.

Royal Air Force

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Flt. Lt. R. J. Floyd; Flt. Sgt. W. G. Godfrey.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—W/O. S. E. Abrams; F/O. H. C. Annett; Sgt. D. Atkinson; Sgt. J. Barton; Sgt. R. F. Batch; Sgt. C. Bayford; Flt. Sgt. J. G. Beardshaw; Act. Sqn. Ldr. C. V. Bennett, D.F.C.; Flt. Sgt. R. J. Bennett; P/O. J. W. Bickerton; W/O. J. M. Bingham; Flt. Sgt. H. E. Bishop; P/O. F. Blunstone; Flt. Sgt. W. Blyth; Sgt. G. R. Boden; Flt. Lt. B. Bonakis; P/O. F. O. Booth; Sgt. H. Boulding; Act. F/O. S. Bowden; Flt. Sgt. W. G. Bowen; Flt. Lt. M. P. Braund; Sgt. A. C. Brett; Sgt. C. Brewer; W/O. A. R. Brooking; Sgt. J. Brown; Flt. Sgt. J. Bryson; P/O. S. J. Bunn; Flt. Sgt. A. Burns; Flt. Sgt. W. M. Burton; Flt. Sgt. C. Butler; Sgt. L. T. Carter; W/O. R. Chandler; Sgt. P. A. Christie; Sgt. W. G. Classen; Sgt. J. W. B. Cockburn; Sgt. C. Cook; W/O. H. F. Coulson; P/O. R. H. Couzens; F/O. W. J. Cowen; Flt. Lt. N. A. T. R. Cowley; W/O. J. M. Crawford; Flt Sgt. H Croucher; Flt. Sgt. D. Davey; Sgt. S. S. De Lisle; Flt. Sgt. H. E. Derrington; Sgt. S. J. Dolan; Act. Sqn. Ldr. R. S. Don, D.F.C.; Sgt. J. Donaldson; F/O M. McL. Dowding; Sgt. J. R. C. Duns; Sgt. C. F. Edney; Flt. Sgt. R. English; Sgt. E. W. Evans; Flt. Sgt. J. McF. Farrell; Sgt. D. Fell; Sgt. T. Fetherston; P/O. R. B. Finn; Flt. Sgt. G. Flaxman; Sgt. H. Fowler; Sgt. S. J. W. Franklin; Flt. Sgt. W. J. Furniss; Sgt. R. S. Garland; F/O. J. R. Garling; Sgt. J. Gibb; Sgt. E. H. Giles; P/O. E. A. Goodman; Flt. Lt. L. E. H. Graham; Sgt. R. W. Gullick; Sgt. W. G. Gunton; W/O. G. Hancox, D.F.M.; Sgt. H. Hardwick; Sgt. S. R. Harris; Sgt. A. Helsby; F/O. G. Hill; P/O. E. Hislop; Flt. Lt. F. G. Holloway, D.F.M.; F/O. A. K. Holvey; Flt. Sgt. A. G. Hopkins; Sgt. K. B. Howell; P/O. J. I. Hoyle; Flt. Sgt. W. Hughes; Sgt. R. Hutchinson; P/O. P. J. Hyland; W/O. T. L. Jackson; Sgt. A. James; Sgt. F. H. W. James; Act. Flt. Lt. S. S. Jenkins; Sgt. D. D. Jones; Flt. Sgt. J. H. Jones; W/O. R. Jones; Flt. Sgt. A. Kelly; Flt. Sgt. W. Kelly; Flt. Sgt. R. J. Ketley-Rolph; Sgt. R. King; Sgt. F. H. Lacey; F/O. W. T. Lambert, D.F.M.; Flt. Lt. J. E. Langley; Flt. Sgt. E. Leese; Flt. Sgt. K. F. Lenton; Flt. Sgt. K. P. Lindenboom; F/O. J. W. Lowrie, D.F.C.; P/O. J. L. McCallum; Flt. Sgt. A. McGlone; F/O. J. McGrath; Sgt. J. A. McLaughlin; P/O. J. A. McMullin; W/O. W. McRae; Sgt. F. McWatt; W/O. J. G. Madge; Sgt. N. V. Madgwick; Sgt. J. Mann; Sgt R. A. Marett; P/O. J. G. Marsden; Sgt. H. A. Marshall; Flt. Sgt. W. H. McD. Marshall; W/O. O. H. Martin; Sgt. W. E. May; Sgt. D. W. Maycock; F/O. H. N. T. Medrington; Sgt. R. S. Melton; Sgt. W. F. Merrick; W/O. J. G. Milne; Flt. Sgt. J. H. G. Milsom; Flt. Sgt. D. S. Mitchell; Sgt. G. L. Mitchell; Sgt. P. R. Montgomery; W/O. H. J. Moore; Flt. Sgt. O. C. Moore; Sgt. R. Morley; W/O. G. A. Morton-Moncrieff, Flt. Sgt. C. D. Mountain; Sgt. T. McK. A. Murray; Flt. Sgt. R. S. Must; P/O. B. Nicholls; P/O. F. J. Nicholson; Sgt. D. H. B. Norman; Sgt. L. A. Oldfield; F/O. G. D. Orr; Sgt. D. O'Sullivan; Flt. Sgt. G. Owen; Sgt. L. Oyston; Sgt. C. H. Palmer; P/O. A. K. Parker; Flt. Sgt. G. Parkes; Sgt. E. E. Parkhouse; Sgt. J. Paterson; Flt. Sgt. D. M. Pearce; F/O. C. Pearton; P/O. W. T. Pethard; Sgt. B. J. Phillips; Sgt. A. E. Piggin; Flt. Lt. G. Platts; D.F.C. P/O. J. Pollard; Flt. Sgt. N. G. Prescott; Flt. Lt. J. R. Pugh, D.F.C.; Sgt. W. E. Ranger; W/O. H. W. Read; Sgt. R. A. Reilly; F/O. E. J. Renelt; Flt. Sgt. T. W. Richards; Flt. Lt. A. G. Richardson; Sgt. H. Richardson; Sgt. R. Rickeard; Flt. Sgt. T. Robertshaw; Flt. Sgt. S. W. C. Rodman; Flt. Lt. J. S. Runnacles; Sgt. G. F. Rutherford; Flt. Sgt. E. Sharp; Sgt. J. McD. Shaw; Sgt. W. Shaw; Sgt. J. A. Silson; Sgt. D. Sleep; Act. Flt. Lt. R. A. Smith; Sgt. R. C. Soanes; Flt. Sgt. G. Spencer; W/O. E. Standring; Flt. Sgt. J. S. Staples; Sgt. C. R. Starkey; Flt. Sgt. A. D. Steeden; Flt. Sgt. H. F. Stephens; Flt. Lt. D. F. Stewart; Flt. Sgt. G. Stewart; P/O. J. R. Tanner; Sgt. F. J. Tate; Sgt. H. Taylor; P/O. E. A. Thomas; Sgt. G. T. Thorley; Sgt. N. Tinsley; Sgt. G. R. Tease; Flt. Sgt. E. W. S. Tomkins; Sgt. G. R. Traylen; F/O. J. K. Turner; Sgt. W. F. Turner; F/O. D. V. Turnpenney; F/O. R. W. H. Usher; Sgt. D. J. Walters; Sgt. H. L. Watkins; Flt. Sgt. R. Watt; P/O. C. W. Way, D.F.C.; Sgt. R. Werrill; F/O. W. E. L. Whitbread; F/O. J. A. Wickson; Flt. Sgt. T. F. Wilcox; Sgt. G. Williams; Sgt. H. R. Williams; Flt. Sgt. J. G. Williams; Sgt. J. B. Wilson; F/O. E. Winton; F/O. T. Wood; Sgt. W. V. Woodall; F/O. B. E. Wright.

PREVIOUSLY REPORTED MISSING, NOW REPORTED KILLED IN ACTION.—Sgt. A. A. Clements; Flt. Sgt. M. C. Eddleston; Flt. Sgt. G. A. Humphrey; Flt. Sgt. R. E. Lapworth; P/O. A. C. Marchbanks; F/O. J. E. Sears; Flt. Sgt. J. C. Tipper; F/O. A. Wood.

MISSING.—W/O. J. A. H. Fawkner; Flt. Lt. M. C. Workman.

KILLED ON ACTIVE SERVICE.—Flt. Lt. G. W. Cotterill, D.F.C.; A/C.2 B. D. Hare.

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PREVIOUSLY REPORTED MISSING, NOW REPORTED KILLED ON ACTIVE SERVICE.—P/O. J. McK. Paulsen.

DIED ON ACTIVE SERVICE.—L.A/C. R. H. Beales; L.A/C. A. K. Bean; L.A/C. E. G. Beardsmore; L.A/C. L. Bray; L.A/C. S. H. Brett; A/C.1 R. S. Curtis; A/C.1 T. W. A. Duffield; Sgt. L. Dunnington; A/C.2 S. H. Element; L.A/C. R. W. Endersby; A/C.1 L. C. G. Falconer; A/C.1 E. J. B. Finn; A/C.2 R. Gale; L.A/C. J. T. Garlick; A/C.1 A. E. Giles; A/C.2 R. R. Goulty; L.A/C. A. J. Grand; L.A/C. R. J. Grenter; L.A/C. R. C. Hamblin; A/C.2 H. O. James; L.A/C. H. L. Lewis; L.A/C. J. McLaughlin; L.A/C. S. R. McNee; L.A/C. H. C. Messer; L.A/C. D. L. Morris; L.A/C. C. L. Murcott; A/C.1 E. A. Murray; L.A/C. G. E. Musgrave; Cpl. D. G. Neil; L.A/C. D. E. Nunn; L.A/C. E. Parsons; L.A/C. R. W. Pennell; A/C.1 B. E. Powell; L.A/C. J. L. Revell; A/C.1 L. R. Reynolds;; L.A/C. W. L. Rust; A/C.1 W. Scaife; Flt. Lt. J. C. Thompson; A/C.1 B. Uren; A/C.1 C. H. Varney.

Royal Australian Air Force

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Flt. Sgt. H. K. Harley.

Royal Canadian Air Force

KILLED ON ACTIVE SERVICE.—P/O. W. F. Conley; Act. Cpl. W. J. Ellis; F/O. W. E. Lang; Flt. Sgt. A. E. Stinson.

WOUNDED OR INJURED ON ACTIVE SERVICE.—W/O. J. P. Belanger; F/O. A. P. Coleman; L.A/C. R. E. Henderson; Flt. Sgt. F. J. Moran.

Royal New Zealand Air Force

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—W/O. L. J. Bennett; Flt. Sgt. T. W. Coombridge; Flt. Sgt. M. D. S. Davis; P/O. J. A. Howard; Act. F/O. H. S. Miles; Flt. Sgt. Olds; Flt. Sgt. E. A. Roy.

South African Air Force

MISSING, NOW BELIEVED KILLED IN ACTION.—Maj. H. J. E. Clarke, D.F.C.

PREVIOUSLY REPORTED MISSING, NOW BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Lt. J. C. Pyott.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Lt. D. K. Austin; Lt. L. Badenhorst; Lt. R. L. Chegwyn; Capt. L. J. De Jager; 2/Lt. I. B. Dell; 2/Lt. I. J. Doble; Capt. B. G. S. Enslin; W/O. R. J. Faull; 2/Lt. C. D. Foord; Lt. L. P. Fourie; W/O. J. N. Geldenhuys; Lt. N. J. Henneke; Lt. P. E. Hill; W/O. F. C. Howe; Lt. P. A. Klapper; W/O. A. J. Kruger; W/O. E. A. Kruger; Lt. G. R. Lacey; W/O. L. Leviton; W/O. G. C. Mayhew; Lt. G. C. Nel; 2/Lt. C. E. Park; Lt. R. Perkins; 2/Lt. M. F. Reim; Lt. C. G. Richardson; W/O. J. Robbertse; Lt. G. H. Rylands; Flt. Sgt. S. L. Segal; Lt. L. Senior; W/O. F. J. Slater; W/O. J. U. C. Snell; Lt. I. A. T. Steele; W/O. K. H. D. Taylor; W/O. A. R. Thomas; 2/Lt. P. M. Tylden-Wright; W/O. M. A. Ueckermann; W/O. W. A. J. Venter; 2/Lt. A. Warmback; 2/Lt. T. R. Warner; W/O. S. R. E. Wicht; Flt. Sgt. B. Wicks; W/O. R. V. Wilkson.

KILLED ON ACTIVE SERVICE.—Lt. G. T. Van Rooyen.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED ON ACTIVE SERVICE.—Lt. A. I. G. Holmer.

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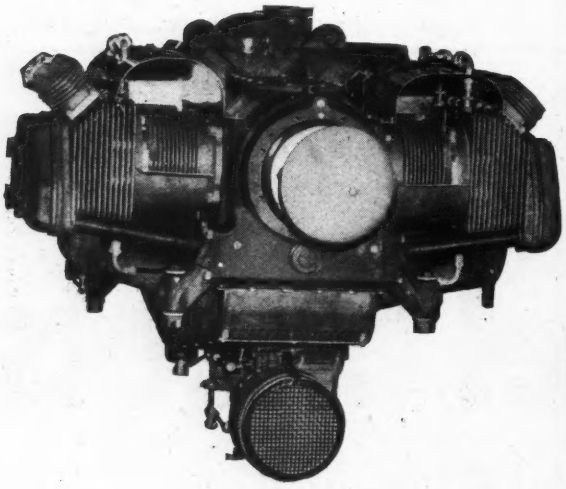

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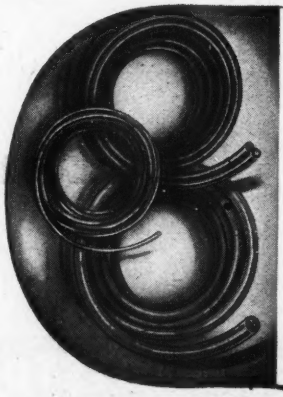

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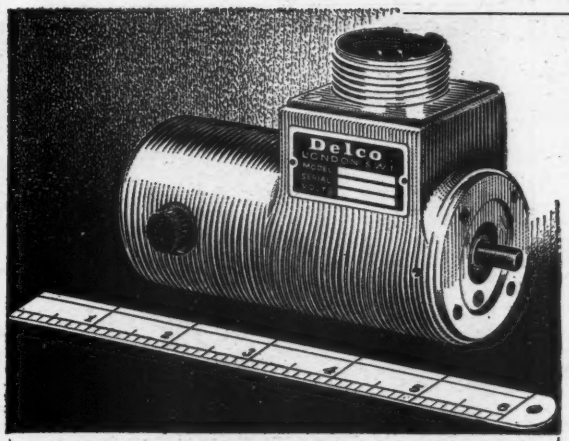

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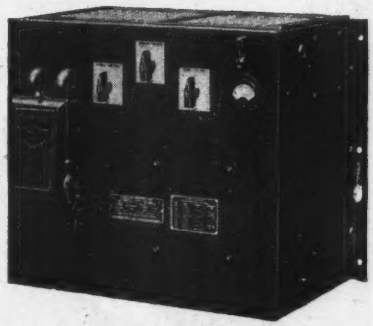

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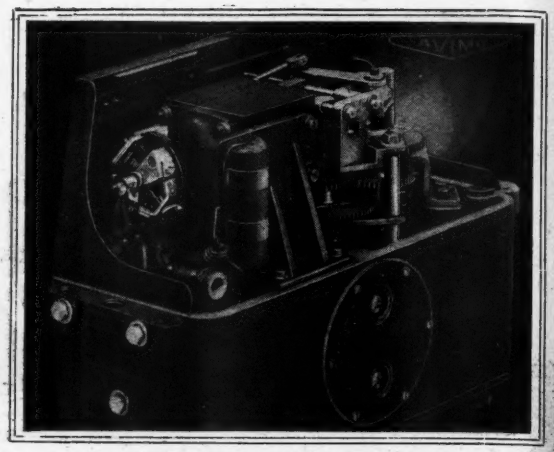

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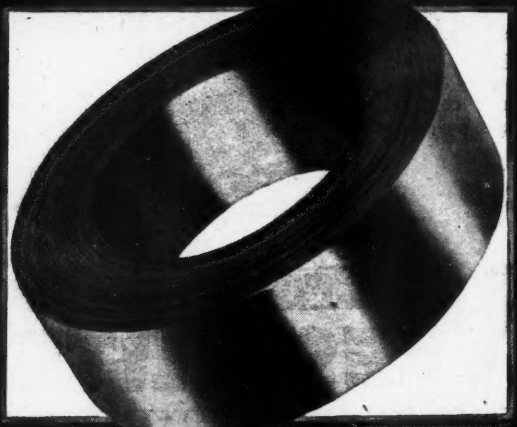

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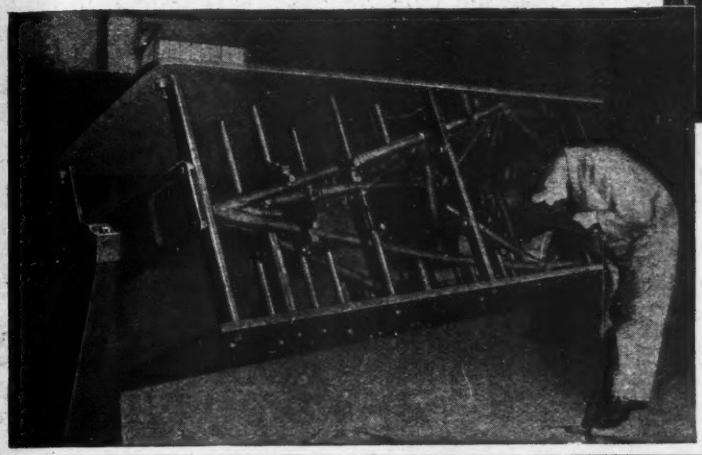

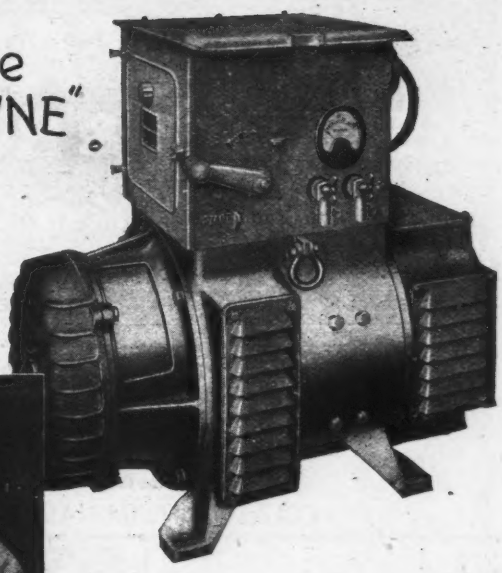

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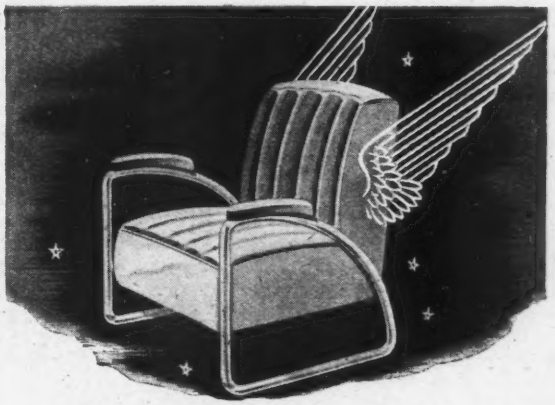

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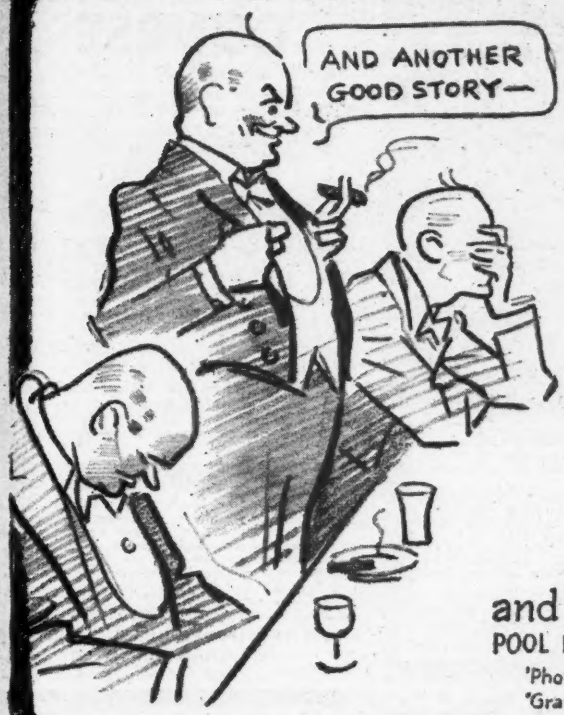

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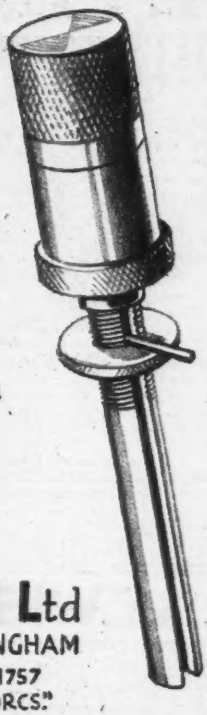

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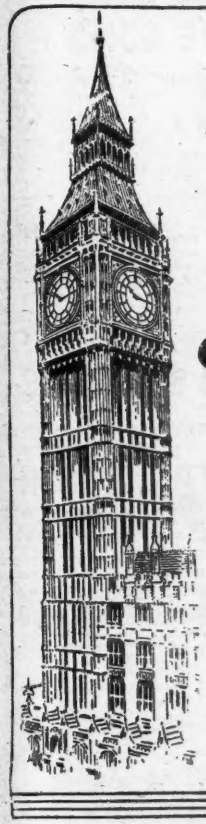

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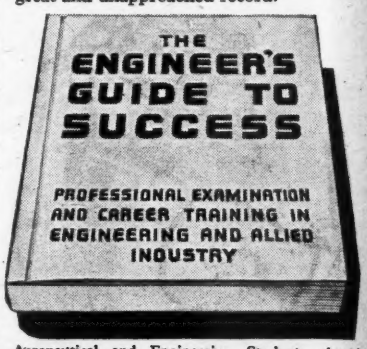

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LECTURER required for aero engine design and materials.—Write Box 925, Armstrong-Warden, Ltd., 69 New Oxford St., London, W.C.1. [7118

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AIRCRAFT firm in the South are prepared to receive applications from experienced persons capable of supervising the assembly and construction of large aircraft metal components.—Write in first instance, stating age, full particulars of experience and salary expected, to Box 240, c/o *Flight*. [7184

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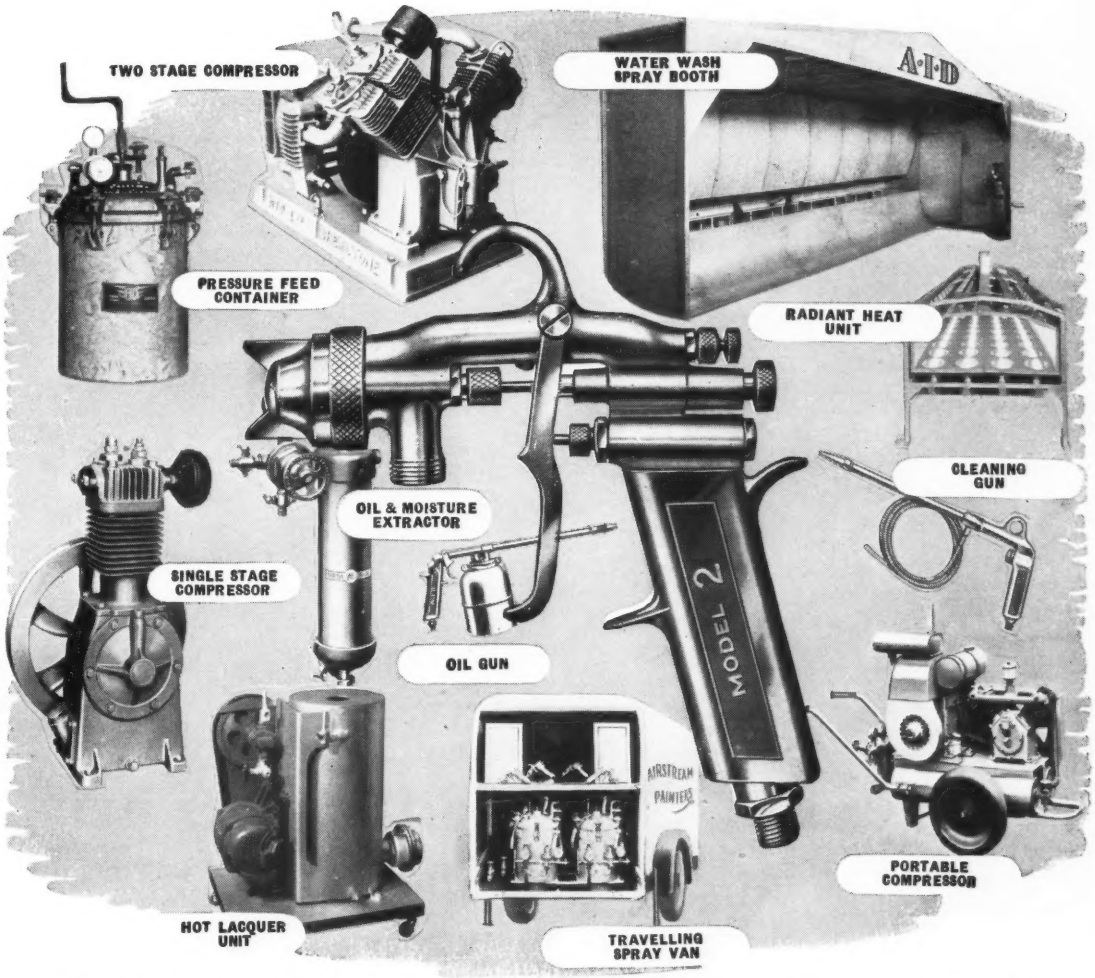

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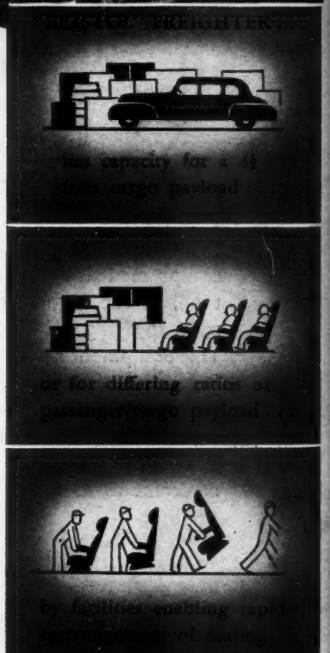
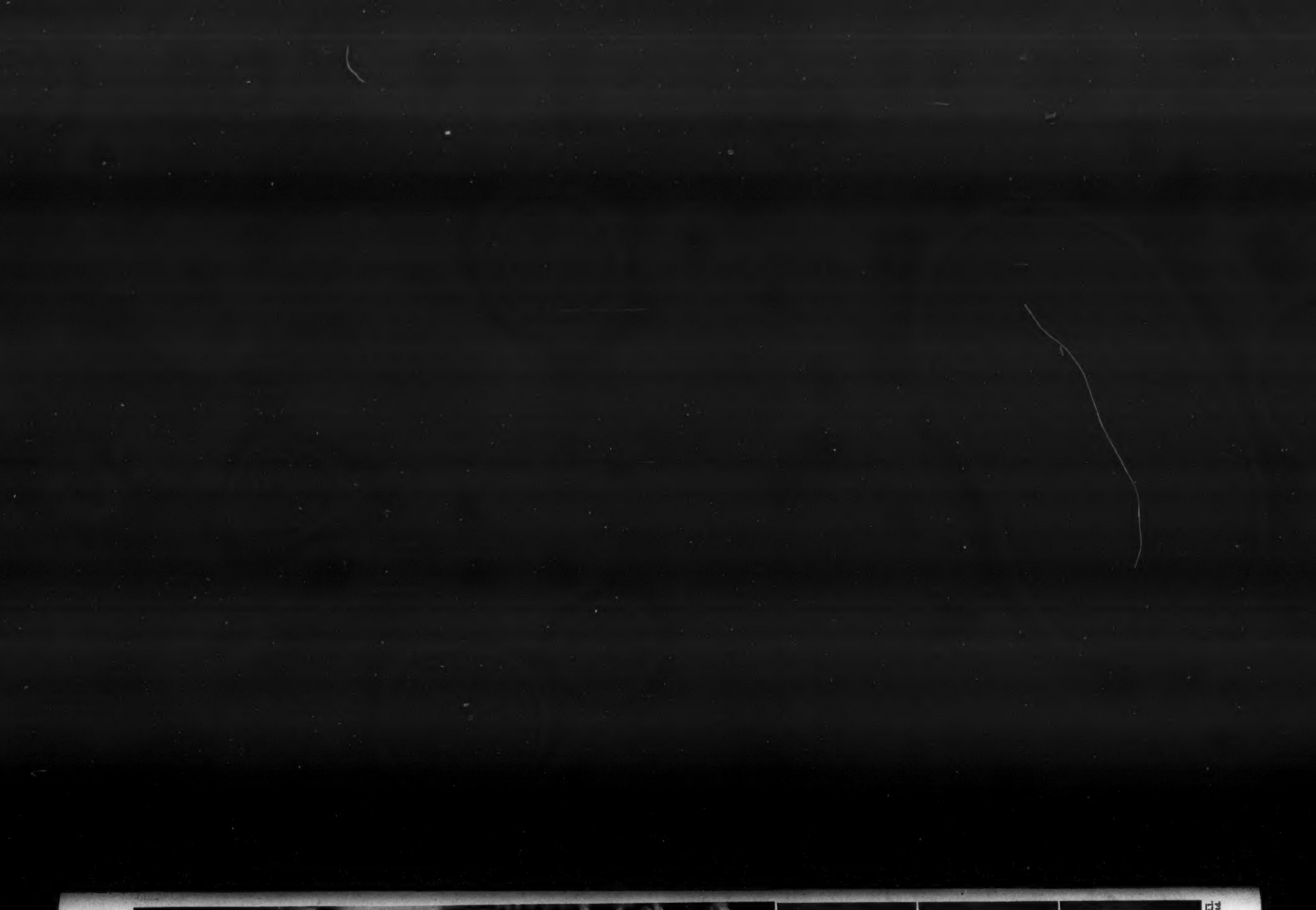
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